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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN.

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NOTES AND COMMENTS.

The Education of the Foundrymen.

This subject, bound up as it is with the question of apprenticeship, is again receiving much attention at the Branch meetings of the Institution of British Foundrymen. During the session 1914-1915 a committee was formed to report on the question of apprentice training. Though a fair amount of information was collected and co-related, and a syllabus was provisionally advocated, no real practical results have been forthcoming in England, and thus, after six years, it would seem that if it is not necessary to start again, it is at least desirable that the committee referred to should be resumed. In Scotland, however, a foundry class is being conducted by Mr. Matt Riddell, the President of the Institution, and his efforts are producing excellent results. We are convinced that a foundry employee who can satisfactorily pass the examination set by Mr. Matt Riddell will be the most useful type of workman that it is possible to employ, providing that he has an enthusiastic chief, who will constantly stimulate the man's interest by showing him the way to apply his knowledge to the things of interest which occur in everyday foundry life. The foregoing will be better appreciated by imagining the result of having the majority of foundry employees sufficiently trained to answer intelligently five out of seven of the following questions which constituted the examination paper for Mr. Riddell's class last December: (1) State the different classes of iron ore used for the production of pig iron, and explain how the percentages of silicon, phosphorous and sulphur appearing in the pig are influenced by the working of the blast furnace. (2) Compare the blast furnace with the foundry cupola. (3) What are the ordinary different classes and grades of pig iron? (*b*) Compare the fractures of different grades, and (*c*) What is your opinion on grading by fracture, and why? (4) Describe the various forms in which carbon appears in cast iron, and state the effect these have on the physical properties of the metal. (5) What is the general effect of re-meling pig iron in the cupola, and explain why? (6) State briefly the influence of silicon, manganese, sulphur and phosphorous on the following properties of a casting, vix., total carbon, combined carbon, soundness, shrinkage, hardness and fluidity. (7) Write a short account of the properties of coke suitable for foundry purposes.

Mr. Riddell is well known amongst members of the Institution to hold decidedly strong views on the present system of what he terms "spoon-fed" education, "which often results in the production of reinforced ignorance amongst the persons so educated." He, unlike so many critics who only offer destructive criticism, is putting into definite action his constructive views, which are bound to bear fruit in the near future. Such voluntary classes will do infinitely more good than any special committees that may be set up, and for the system to become national it only requires one man in each iron-founding centre; but he must be possessed of two essential qualifications, which are *knowledge of his subject* and *enthusiasm*. We are inclined to agree with Mr. Riddell that compulsory education has not produced the brilliant geniuses of the old-time voluntary system.

Queries Answered.

Phosphorus in Cast Iron.

1.—Dr. Moldenke states on page 222 of the FOUNDRY TRADES JOURNAL that phosphorus cannot be reduced in the electric furnace until the steel stage is passed. Can this be substantiated?

"ARC."

1a.—The reasonableness of Dr. Moldenke's assertion will be confirmed by reference to a pig-iron oxidation graph, under basic conditions, wherein time is the abscissa and percentage of element remaining in the molten bath, the ordinate. It will immediately be noticed that no large elimination of the phosphorus can take place until oxidation of the silicon and carbon has proceeded. The pig-iron used for a basic Bessemer blow contained 3.35 per cent. carbon, 0.48 per cent. silicon, and 2.0 of phosphorus. By the time the carbon had reached 1.32 per cent., the phosphorus had only reached 1.78, and the silicon had, at this period, practically disappeared. As soon as the "steel" period was really entered into, the phosphorus elimination became rapid, and by the time the carbon had reached 0.02 per cent., the phosphorus had failen to 0.12 per cent. Any attempt to reduce the phosphorus in a pig-iron charge in a basic electric furnace would cause endless difficulties spread over hours of working.

XUM

The Works of Steel Castings, Limited.

Registered in December, 1913, Steel Castings, Limited, took possession of the iron foundry in the Old Edinburgh Road, Parkhead, Glasgow, which was formerly occupied by Messrs. Campbell, Binnie, Reid & Company. The foundry had been idle for some years prior to being taken over by the new Company.

The objective of the new Company was the manufacture, for the trade, of high-class steel castings of all descriptions and heavy gears as a speciality. Pending such time as the necessary constructional alterations could be made to the buildings, etc., a 6½-ton Siemens melting furnace and producer plant was installed by Messrs. Smith, Wincott & Company, Glasgow. This had only just been put on duty when the outbreak of war put an end, for the time being, to further developments, the works as they stood being given up to the production of castings for the Admiralty and gun mountings. With a return to peaceful times, the work of reconstruction was at once put in hand, but this was by no means an easy proposition, as the work had to be carried out without interference with the existing plant, which was taxed to its utmost to meet the abnormal demand.

The new steel foundry is covered by one main bay 260 ft. by 40 ft., served by two 20-ton Royce cranes, and a side bay 160 ft. by 25 ft., which is served by a Smith, Rodley, 5-ton overhead crane.

Fig. 1.—View in Iron Foundry.

The melting plant consists of a Smith-Wincott 6½-ton Siemens furnace and a Stein & Atkinson 15-20-ton Siemens furnace. The furnaces are placed side by side. For a plant of this nature the charging platform (erected by Sir William Arrol & Company, Limited) is exceptional, being 60 ft. long by 35 ft. wide. It is constructed of heavy H-section beams and the floor laid with chequered steel-plates, the platform being equal to carrying a load of 100 tons. On the casting side a platform of similar construction, 6 ft. in width, extends the full length of the furnaces.

Fig. 2.—View in Main Bay of Steel Foundry.

Gas is supplied from three producers. The pull on the smaller furnace is through a steel stack 70 ft. by 3 ft. 9 in., whilst for the larger furnace the old brick stack, 75 ft. by 3 ft. 6 in., does the duty. The charging platform is common to the three producers, and the coal is delivered to the

platform by a Grieve 3-ton electric jib-crane, the same crane also serving to deliver the material to the furnace charging platform. Suspended from the crane hook is a 5-ton Salter balance, so that the weight of all the material is checked and

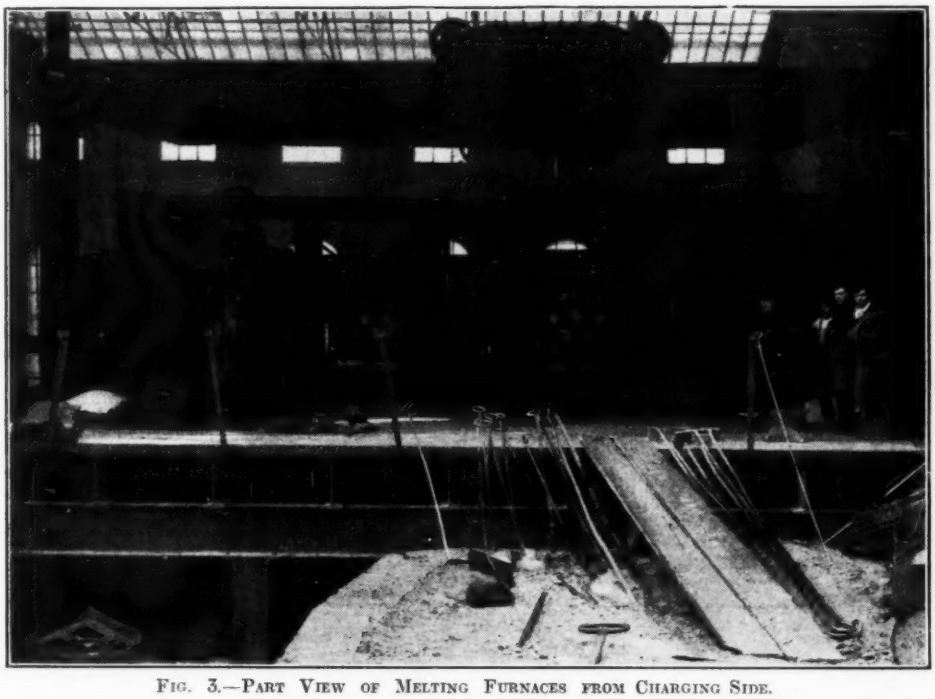

FIG. 3.—PART VIEW OF MELTING FURNACES FROM CHARGING SIDE.

recorded as handled. The laboratory for works tests is situated at the side of the furnace platform.

The three main drying stoves, two 25 ft. by 12 ft. by 10 ft. and one 22 ft. by 12 ft. by 10 ft. are fired from the furnace producers. The gas valves for these furnaces are nothing more than an iron plate placed above the gas flues. Combustion is completed in a chamber built into the end of the stove chamber, and the products of combustion enter the chamber through chequered brickwork; the drying effect is in every way excellent, as a current of hot air is maintained by an electrically-driven fan. When there is a heavy call for gas at the furnaces, the valves on the stoves are closed more or less, and the stored heat in the combustion chambers becomes available. The casting floor is devoted to heavy engineering and electrical work, castings up to 15 tons being made, whilst gears up to 9 tons in weight, 10 ft. in dia. by 30 in. face, have been cast.

The smaller bay is devoted to core making and work of a light nature. The core stove, built by the Company, is of decidedly novel construction. The sides of the roof are H-section beams, bolted across, with the arching built in between them, the roof is thus an entirely independent structure which simply rests upon the side and end walls, and is free to slide upon them as expansion or contraction takes place.

FIG. 4.—FETTLING SHOP.

The annealing shop, 65 ft. by 28 ft., is served by a Smith, Rodley, 15-ton crane.

The annealing furnace, 20 ft. by 10 ft. by 5 ft., except for the roof and the last 2 ft. of the walls is built into the ground, which, it may be mentioned is of heavy clay, and thus forms an excellent protection against radiation losses.

The furnace is covered by a three-section roof; the gas enters the furnace through three separately controlled valves, each inlet being served for the

passage of the products of combustion by an independently controlled damper in the main flue. It will thus be understood that either chamber can be worked independently or when worked, as is usually the case, as a single-chamber furnace, there is a perfect control of the temperature, the gas being throttled when necessary to meet the varying weights of material in any portion of the furnace, a condition which not only has an important effect upon the metal under treatment, but also enables the furnace to be worked on the most economical lines. Indeed, the results obtained in everyday practice with this furnace are very remarkable, as we are informed that with the furnace fully charged the fuel consumption does not exceed 4 cwts. per ton of metal annealed. Gas control is of course the most important consideration, but an important contributing factor is the wall of clay surrounding the furnace chamber, as it is found in practice that the soaking heat can be maintained over a long period with the gas entirely shut off.

Gas is supplied from a 7-ft. producer, which is so disposed that the fuel can be discharged direct from the railway truck on to the producer platform. The steel stack is 50 ft. by 4 ft. The furnace, producer plant, etc., were designed and built by Messrs. Smith, Wincott & Company, Glasgow, in consultation with Mr. H. Archibald, managing-director of Steel Castings, Limited.

down cost. The re-inforcement consists of the usual arrangement of bars, the aggregate consisting of firebrick and silica sand, with an admixture of old nails, brads and the like which were not worth recovering for re-use. It was found on a test-piece that these gave remarkable strength and elasticity to the concrete. In any case, contrary to the generally expressed opinion, the structure has proved remarkably stable and thoroughly serviceable.

The producer built on to the back of the stove consists of a firebrick chamber, with charging holes at the top and coned towards the bottom on to a 3-ft. by 3-ft. grate, below which is a water pan. The air for combustion is preheated by passing through flues in the side walls of the producer. Combustion is completed in a brick chamber the same section of the stove, into which the necessary secondary air is admitted, and from which the products of combustion pass into the stove through ports in the brickwork. The producer is fired with coke ballast and gives excellent results. For the general castings Belgian sand is used exclusively, but for moulding gears and certain other special classes of work a moulder's composition is employed.

The cupola fan is installed in the same house as a compressor by the Consolidated Pneumatic Tool Company, of 360 cub. ft., at a pressure of 100 lbs. per sq. in., which is belt-driven from an 80-h.p.

Fig. 5.—Large Annealing Furnace (Two Sections of Roof Removed).

The fettling shop occupies an entirely independent building, 140 ft. by 68 ft. by 28 ft. high to the eaves; the crane equipment comprises a Royce 10-ton, and a Smith, Rodley, 2-ton overhead cranes. A Tilghman's sand-blast plant is installed, and there is the usual complement of grinders and pneumatic tools.

A number of cutting-off saws are installed, but for the most part these are no longer in commission, their duties being done by the oxy-acetylene and carbon-arc processes, the first-named only being used on castings where no subsequent machining has to be done. Castings are brought from the foundry to the fettling shop by a 7-ton loco. crane (Cole, Derby), and this crane, in point of fact, serves the whole yard.

The iron foundry, where for the time being castings up to 5 tons in weight are being made, is covered by a bay 120 ft. by 40 ft., and served by an Arrol 5-ton crane. Metal is brought down in a Thwaite cupola of 3 to 4 tons per hour capacity, which is served by an electric hoist and blown by a Keith-Blackman fan, which is driven through belt by a Brooke 25-h.p. motor.

The drying stove calls for special mention, as it is distinctly unusual to find ferro-concrete used for such a purpose. The producer or generator is also of novel form, the whole having been built to the designs of Mr. Archibald. In using ferro-concrete for the roof of the stove, which is 25 ft. by 12 ft. by 10 ft., the main object was to cut

Brooke motor. The test house contains a 30-ton Olsen machine, which is driven by a reversing motor, and upon which tensile, bending, and cast-iron tests can be made. In this room is also the works sub-station, the Company taking direct current at 500 volts, and also a supply of alternating current at 440 volts 3-phase.

At a recent meeting of the American Society of Mechanical Engineers, H. S. Rawdon, of the Bureau of Standards, Washington, stated that it seems impossible to fuse metal electrically without serious imperfections, and that the mechanical properties of the arc-fused metal are, therefore, dependent to an astonishing degree upon the skill, care and patience of the welding operator.

A recent issue of the "Iron Age" announces that Prof. A. E. Wells, Sibley College, Cornell University, Ithaca, N.Y., has made a plea for the co-operation of foundrymen in giving summer employment to students taking foundry courses in his university. Last summer seventeen Cornell students were so placed and returned to college in the autumn. Each made a report of plans for improving the foundry in which he was employed. Among the bad conditions found were: Dinginess, dustiness, insanitary conditions; need of more space, cranes and co-operation of men.

Some Properties of 60 : 40 Brass.—Part II.*

By Cecil H. Desch.

It has been stated by several writers that the Brinell hardness of a brass is a satisfactory indication of its machining quality, and it was decided to test this point. No Brinell machine was available in the Glasgow laboratory at the time, so it was decided to employ the auto-punch method, which is known to give good results. A heavy Brown and Sharpe automatic centre punch was altered by removing the point and substituting an adapter holding a one-eighth inch bicycle ball. On holding the punch vertically against the specimen and pressing, a blow was delivered, and an impression was produced, the diameter of which could be measured under the microscope by means of an eye-piece micrometer. Four impressions were

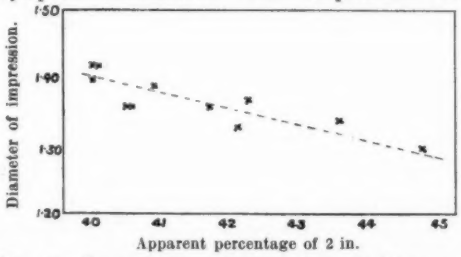

Fig. 2.—Influence of Zinc on Brinell Hardness.

usually made on each part to be tested, each impression being then measured on two diameters at right angles, and the mean of the eight readings taken. The results are collected in Table IV. The hardness of each bar was delivered on a line about half-way between the centre and the circumference, and also on a transverse section, the portion near the centre and that as near to

Table IV.

No.	Diameter of auto-punch impression. m.m. Centre.	Edge.	Brinell hardness number. Centre.	Edge.
609 ..	1.35	1.30	80	80
610 ..	1.20	1.15	85	129
611 ..	1.32	1.27	82	95
612 ..	1.21	1.24	107	107
613 ..	1.35	1.25	87	97
614 ..	1.32	1.29	97	100
615 ..	1.27	1.38	85	89
616 ..	1.24	1.30	97	97
617 ..	1.18	1.22	103	107
618 ..	1.19	1.17	113	110
619 ..	1.41	1.28	82	95
622 ..	1.42	1.38	107	92
623 ..	1.32	1.24	97	121

the edge as could be tested without distortion being tested separately. The results obtained at the centres of the transverse sections were, on the whole, the most concordant, but on plotting against either the real or the apparent percentage of zinc, a definite relation could not be found. The majority of the points lie in such a way as to indicate increasing hardness with increasing zinc, but three points lie so far from the curve that the differences must be more than accidental, and one of these three is No. 618, which is undoubtedly the best of all to machine, but which gives the highest value for the hardness by the auto-punch method of all the bars examined in that series. On repeating the experiments at a later date with a lever Brinell machine, the soft brass 618 once more gave as high a reading as the hard brass 612, containing an excess of the β constituent.

Table IV. also contains the results of tests made in Sheffield on the same specimens, using a Swedish Brinell machine of the usual type. The results are quite similar to those previously obtained.

It has been stated that the Brinell hardness of a brass may be accepted as a measure of the hardness in machining.† Plotting the machining times against the Brinell numbers, however, no such relation is found, and an examination of the data contained in Mr. Ellis's paper shows that the conclusion is unjustified. When the data given in that paper are plotted they are found to be distributed in an apparently random fashion, so that no curve drawn amongst them has any justification. The writer is convinced that the Brinell hardness is unconnected with the machining quality of a 60 : 40 brass.

The process of scratching a metallic surface with a diamond or other hard point closely resembles that of cutting with a tool, and it was therefore thought that a useful test of hardness might be made by means of the sclerometer, an instrument long used for the determination of the hardness of minerals, and modified for application to metals by Prof. Turner.‡ Finding that the usual construction of this instrument was insufficiently rigid, so that the arm carrying the diamond was liable to shake during the making of the scratch, producing a wavy line on such a tough metal as brass, an improved instrument was constructed, in which the light pivoted arm was replaced by a rigid rhombic frame, supported by two hardened steel conical pivots 6 in. apart, and balanced so as to swing freely. The specimen was supported on a carriage moving between parallel guides, having an elevating pillar to accommodate specimens of different sizes, and screw traversing motion allowing several parallel scratches to be made. Four scratches were made on each specimen under the same load, and the breadth of each scratch was then measured at two different points under the microscope, using a Ramsden eyepiece micrometer. The surface of the specimen was always polished before testing.

The difficulty found in applying this method arises from its extreme delicacy. Duplex alloys, such as $\alpha\beta$ brass, show a scratch which is not uniform in breadth, but consists of a series of alternately broad and narrow portions, corresponding

Fig. 3.
No. 351 x 50.

with the relatively soft α and hard β respectively. It is therefore necessary either to use a heavy load or to measure under so low a magnification as to obtain the average breadth. The results are shown in Table V.

Table V.

No.	Breadth of sclerometer scratch. Divisions of eyepiece micrometer. Centre.	Edge.
609	53 ..	52
610	50 ..	50
611	52.5 ..	51
612	44 ..	40
613	47 ..	37
614	50.5 ..	36.5
615	53 ..	50
616	49.5 ..	43
617	42 ..	33
618	52 ..	50
619	37 ..	35
622	53 ..	52
623	39 ..	37.5

* Continued from Page 253.

† O. W. Ellis, J. Inst. Metals, 1917, 17, 25.

‡ Proc. Birmingham Phil. Soc., 1886, 5, 291.

Plotting the measurements against the machining times, no definite relation is observed beyond the sharp separation into two groups, previously noticed. It is intended to continue this part of the investigation, as it would seem desirable to have a laboratory method which would enable the working hardness of a brass to be determined with speed and accuracy, and a sclerometric method appears to promise more than any other as yet available.

It is frequently reported by machine shop workers that a bar has a hard skin on the surface, which causes blunting of the tool at the first cut. Brinell and scleroscope measurements across a transverse

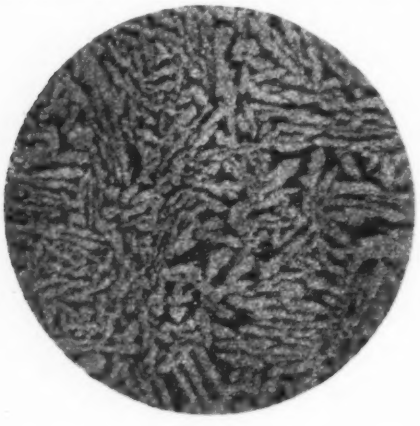

FIG. 4.
No. 352 x 50.

section of a bar frequently, but by no means always, show an increase of hardness as the edge is approached. This is due in part to greater closeness of grain in the outer portions and in part to cold working. The writer has found no evidence of hard particles of oxide in the outer layers. The bars as received are usually remarkably free from oxide, and in the few cases in which oxide has been found it is of a light, powdery nature. Neither can the skin hardness be attributed to rapid cooling at the surface, retaining the brass in the hard β condition. On the contrary, the outer zone is always slightly richer in α than the interior, owing to a small loss of zinc during the processes of manufacture. Attempts have been made to determine

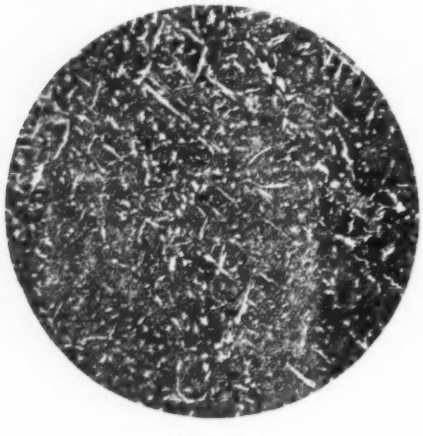

FIG. 5.
No. 612 x 50.

the hardness of the original skin, both by Brinell and by sclerometric methods, but the results have been unsatisfactory, the surfaces of some of the bars being so rough that accurate measurements could not be made, whilst grinding or polishing the surface would have defeated the object of the experiment.

Two bars were received which had been pickled in acid in order to remove oxide. The machining tests did not indicate that the metal was appreciably softened thereby, and, in view of the evidence in the last paragraph, it is not to be expected that pickling would be of any great advantage.

Portions of some of the bars were annealed by heating for two hours in a muffle at 700 deg. C., the specimens being packed in kaolin to avoid oxidation. They were then ground and polished, and tested by the auto-punch method. The effect on the structure was to coarsen it slightly and to cause rounding of the α crystals when these were previously angular. The diameter of the impressions is given in Table VI. and plotted in Fig. 2. The relation between the Brinell hardness and the percentage of apparent zinc is brought out clearly, the bars now being in a comparable condition.

TABLE VI.

	Hardness of annealed specimens. Diameter of auto-punch impression.
No.	m.m.
609a	1.40
610a	1.36
611a	1.42
612a	1.30
613a	1.39
614a	1.37
615a	1.34
616a	—
617a	1.36
618a	1.42
619a	1.33
622a	1.36

The influence of the structure on the machining quality of the brass is well illustrated by Nos. 351 and 352. It will be seen from Table 1 that the composition of these two specimens is practically identical, but workshop reports gave the former as soft, and the latter as hard, in the automatic

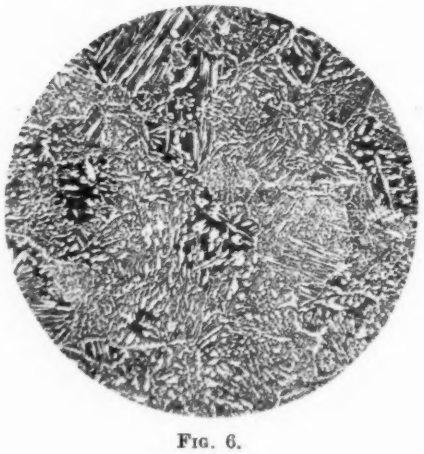

FIG. 6.
No. 615 x 20.

lathes. The photo-micrographs, Figs. 3 and 4, show that the α crystals are arranged in the one case in an almost parallel fashion, giving a fine fibrous grain to the metal, whilst in the other they are coarsely angular. The difference of hardness in this case is to be attributed to differences in the treatment of the metal after casting. Figs. 3 and 8 illustrate the conclusion, which the writer has reached as the result of this investigation, that a fibrous structure is favourable to ease of machining. It is only necessary to compare the photographs with the records of the machining times in Table 2.

A few words may be said on the subject of variations from the normal 60 : 40 composition. It is the practice of some manufacturers to use a considerably larger proportion of zinc in billets intended for extrusion. The higher the zinc the more readily is the alloy extruded under the usual conditions of temperature. This procedure results in the production of a bar which is hard to machine. By far the best results are obtained from an alloy containing 40 per cent. of apparent zinc, whilst the true percentage should be only slightly less, the difference being made up by lead. The quantity of the latter metal may approach 2 per cent., but 1.5 per cent. is probably sufficient in most cases. Tin, iron, and aluminium should be reduced to the lowest possible proportions. The best alloy in the whole series, as proved by workshop experience extending over many months, was the American brass, No. 618, and this was used

as the standard of comparison throughout the experiments. It has the highest chemical purity of any of the specimens, and contains exactly 40.0 per cent. of apparent zinc. One of the worst is No. 616, which contains the largest quantity of impurities.

Extreme variations are no doubt sometimes due to errors in weighing out the ingredients before melting. Two examples are seen in Nos. 694 and 712. The former consists of the α constituent, with only occasional traces of β, whilst the latter contains so high a proportion of zinc that the β crystals are bordered by layers of the γ constituent, an exceedingly hard and brittle substance of a light-blue colour. Brasses which contain even a minute quantity of γ are excessively brittle and may be broken by a light blow. Such a composition is only to be attributed to accident.

A comparison of the results leads to the conclusion that an arrangement of fine, fibrous α crystals, separated by a comparatively small quantity of β, is the most desirable structure for machining purposes. This is obtained by employing an alloy containing as nearly as possible 40 per cent. of apparent zinc, and extruding at a moderate temperature. Such an alloy, however, flows less readily than one with a higher proportion of zinc, and powerful presses have to be used. Some experiments were made with a series of billets containing 60.5 per cent. of copper, and these were extruded in the ordinary way from a 600-ton press. The billets proved to be very hard and were liable to stick in the press, so that three of the bars produced were only of one-half the normal length, half of each billet being left in the press. The structure was quite satisfactory, being fine and fibrous. It was ascertained that the presses used by the American firm which produced the brass No. 618 were of much greater power. It would be possible to use the presses of lower power for the 60 : 40 alloy, but the temperature would have to be high, and the fine structure would not be obtained.

Discussion.

A MEMBER said that many of them found it was a very difficult thing to turn 60:40 brass. During the course of the war he had had occasion to make some experiments, and he did not quite agree with Dr. Desch that the fibrous portions

FIG. 7.
No. 616 x 50.

under the microscope were any guidance. He had made some hundreds of microsection and chemical analyses, and he found that the mechanical treatment of the brass very largely affected the microstructure. The point which gave machining properties was he believed the percentage of lead. He found that when they got up to 2 per cent. of lead they had very little difficulty. Brass containing manganese, tin, etc., gave them considerable trouble. He would like to have some information as to the influences of composition.

Another speaker said he found that with ordinary care in the foundry a cast bar stood up equally as well in the machining with the same mixing as the extruded bar. With reference to annealing, he would like to know if Dr. Desch could give them the maximum temperature reached in the annealing; did he allow them to get cold and then raise them to the temperature?

DR. DESCH said he had been asked whether he considered the fibrous structure was a guide to the machining quality. He could not be dogmatic on that point. The gentleman who asked the question said that in his experience it was not. All he (Dr. Desch) could say was that in the works the highest output was given by those that had fibrous structure. He did not find that the machining quality was different. He was very much

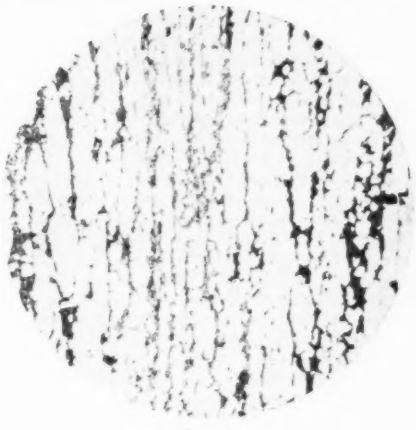

FIG. 8.
No. 618 x 50.

interested to hear cast bars had been obtained as good as the extruded bars. He had heard that a certain amount of rolling was good for a bar. His experience was that very little difference was made. With regard to aluminium, he would not advise the use of it in making brass. Referring to the subject of annealing temperature, Dr. Desch said it was 700 degrees C. maintained for two hours.

MR. WHEATLEY said, with reference to the extruded metal in comparison with the cast metal, as shown by the microstructures, in the extruded metal, it seemed that the microstructure was very much more uniform. That he considered rather pointed to the fact that there were different forces acting. When rolling a metal the forces set up were entirely different from the forces resulting from exclusion. In extruded metal the forces tended to squeeze the metal together and gave the more uniform structure.

DR. F. C. THOMPSON said that he had no experience of dealing with brass of the 60 :40 composition for machining purposes, but he could bear out entirely what Dr. Desch had said with regard to the addition of other metals failing to fulfil certain specifications. He would like to have an idea of the material used for dies in these processes.

DR. DESCH, in the course of his reply, said that with regard to the size of the billets, the usual procedure was to cast into billets, which could then be cut into the proper size. The billet was then heated to the proper temperature before being put into the press. The dies were of chrome steel, and they were changed so as to prevent overheating. Providing the temperature was high enough he saw no difficulty about drop stamping. But the main difficulty there was when the presses were not sufficiently heavy. At the time the experiments to which he had referred were made electrical furnaces for brass work had not been introduced into this country.

A vote of thanks to the lecturer concluded the proceedings.

SINGALESE PLUMBAGO.—A severe slump has been experienced in the plumbago trade of Ceylon. Exports, which totalled 33,000 tons in 1916, only amounted to 6,671 in 1919. It has since, however, shown some signs of improvement, as 4,235 tons were exported in the first five months of 1920. Before the war the United States, United Kingdom, and Germany each imported approximately the same value of Ceylon plumbago.

The Testing of Steel.*

By D. Sillars.

Turning now to the testing of steel, it is obvious that no method of determining the strength of the material can be so satisfactory as one in which the stresses which are to be put upon it in practice are reproduced in the test. Stresses, however, are frequently of so complex a character that it is not possible to reproduce them and to subject the member to these stresses for a sufficient length of time to ensure its ability to withstand them indefinitely. The next best approach to the question is to single out some one property which is essential to stability and to determine its value with all the accuracy possible, and to deduce therefrom as far as may be the other properties of the material. Such a property is the elastic limit, or more correctly the elastic range, of the material—that range wherein, when stressed, the material suffers no permanent deformation, however long or repeatedly the stress is applied. Many experimenters have succeeded in finding a fair approximation to the value of this property in individual cases, but so many are the conditions which affect the results, and so tedious and time-consuming are the actual tests, that some more practical, if less perfect, method had to be found. The method generally adopted is to stress a piece of the steel of regular dimensions until, on measuring the distance between two points after unloading, the piece fails to return to its original dimensions. The accuracy secured, it will be evident, depends upon the delicacy of measurement of the strain produced, and in ordinary commercial measurement a pair of screw callipers are used with which a permanent set of one-hundredth of an inch may be observed. The method cannot be said even to approximate to the true elastic limit, and more accurate measuring devices or extensometers are made use of very successfully up to a limit of one ten-thousandth of an inch, at which point there is no doubt that a fair approximation to the true elastic limit is obtained in normal material; but at best it is an approximation, and the term "yield point" is the better one when the determination requires the observation of a permanent set to distinguish it. The true elastic limit cannot even be defined, for it is known that material which will stand a certain stress once will fail if stressed to the same extent repeatedly, and it is also known that the initially applied stress will have the effect of raising the elastic limit, thereby, one would expect, enabling it to sustain the further applications of the same intensity of stress with greater ease. Wohler and his successors have determined that there is a point up to which stresses can be applied repeatedly and indefinitely, and that this stress is not related to the elastic limit as determined by permanent set, however small. For instance, Nusbaumer took a bar of uniform quality, and hardened one half and annealed the other at suitable temperature; he rotated both pieces together under the same weight in the same machine at the same time, and, although the elastic limit of the hardened bar was four times that of the annealed bar, yet both bars broke by progressive fissuration after the same degree of endurance. There is no doubt that the most satisfactory method of ascertaining the properties of a metal is to make a tensile test with a delicate extensometer, and from the observations to plot a load-strain diagram. Three points of value will be noted: first, the point at which the strain ceases to be proportional to the stress; second, the yield point where the piece fails to return to its original dimensions when unloaded; and third, the maximum load and breaking load; while from the test-piece dimensions the elongation is determined. With such a diagram the engineer is in a position to say what stresses his material will bear, and if he were able to say with equal precision just what stresses will come upon the members of his design then many of his troubles would be happily ended.

If we consider what information is given by an ordinary tensile test it will be found that the observations usually made are unrelated to one another. The load is applied until the yield point is observed; loading is then continued until the stretch is very obviously beyond the yield point, at which point the reduction in diameter of the bar ensures rupture without further application of load; finally, the elongation is measured, not, it should be observed, at maximum load, but at maximum load at breaking point on the area reduced by elongation. The results, therefore, are yield point unrelated to extension, maximum load unrelated to extension, and extension related to nothing that matters.

If the nature of the change taking place in the extension of a bar after passing the yield point be considered, it will be seen that not only is it complicated by the sudden and rapid local reduction in area taking place at rupturing point, whereby we have no knowledge of extension at the moment of maximum load, but, in addition, the general extension up to maximum load cannot be considered a result of extension uniformly distributed between the gauge points, since it must vary from a maximum at the centre of the distance between the gauge points to a minimum at the gauge point, and the extension, even if taken at the moment of maximum load, is the sum of all these quantities.

Although an ordinary tensile test may be quite sufficient for the purpose of fixing compliance to a specification, it leaves much to be desired by the engineer who is investigating materials for construction. Herein lies the value of a load-strain curve.

The operation of taking a load-strain diagram is, however, a tedious one, and it is quite out of the question to construct it for each cast of steel; even to determine the yield point by the callipers method is not possible where, as in most steelworks, hundreds of tests must be broken in a day if the requirements of specifications are to be fulfilled. As a consequence, designers generally deduce the elastic limit from the breaking strength, adopting a factor which experience dictates as appropriate to the circumstances, and trusts to the elongation to ensure that no brittle material is used. That such an approximate method is not always justified is well known, and while the number of cases in which it is likely to cause serious under-estimation is probably few, probably it is not so well realised as it should be that steel can in exceptional cases fall so far below the expected results as to seriously falsify calculations based on breaking load. A case actually occurred in which the maximum stress at breaking point was 31.6 tons, the yield point 14.1 tons, limit of proportionality, instead of 12 to 13 tons, was only 7.4 tons, so that a factor of safety of 4 to 1 would exceed the elastic limit.

To detect such cases it has been a constant endeavour of engineers to devise some test of easy application which would show up any abnormality. No simple test so far discovered has been found to bear any definite relation to a single property of the steel such as the elastic limit, or by itself to detect an abnormal condition not identifiable by a careful tensile test. Much interesting work has been done, however, and the results of some of the newer methods of testing, when interpreted properly in conjunction with a tensile test, are valuable and often reveal defects or excellences of an unexpected nature.

Before describing these testing methods it is desirable to make some general remarks on the manner in which fracture in metals is brought about, and to do so without introducing any more unusual terms than can be avoided by the nature of the case. I shall therefore confine myself to some well-ascertained facts capable of demonstration, and leave out any mention of the many interesting hypotheses which have been constructed to explain the facts.

Iron is a crystalline body; that is to say, when it cools from the molten state to its freezing point it adopts, on reaching the solid state, a

*Extract from a paper read before the Middlesbrough High School Engineering Society.

regular structure with regard to the internal architecture of the particles of which its mass is made up. If given sufficient time in passing through the change from liquid to solid it will also adopt a regular geometrical form for the external dimensions of its individual particles.

Generally this time is denied the cooling metal, so that its particles interfere with the growth of each other, and, crowding together, distort the plastic metal and force the crystals to adopt an irregular shape for their external dimensions which is not recognisable as any other than a mass of polygonal grains. The internal structure of the crystals is built up of crystalline elements symmetrically disposed to one another. The junctions of these crystalline elements are called the cleavage planes, and along these planes fracture of a crystal takes place.

When highly-polished metal is strained slightly, but permanently, after etching with an acid, its surface shows one or more series of parallel lines within each polygonal grain, which end abruptly at the boundaries of the grain.

These lines are the visual indication of slight inequalities which have formed on the surface during straining, and are caused by some of the crystalline elements which form the whole crystal slipping at the junction of cleavage planes and assuming a stepped appearance like bricks built to a slope.

This slipping is the first indication that the elastic range has been passed, and if the stress causing the slight slipping of the cleavage planes be maintained at the same intensity no further change will ensue. By releasing the load causing the stress, and applying it again or by increasing it, further slipping will occur, and by repetition a definite fissure or crack will form. The point especially to note is that fracture has taken place through the cleavage plane and not at the boundary between the grains. The introduction into molten metal of some foreign substance which is not soluble and does not enter into and remain in the composition of the crystal, or which is present in amounts greater than the crystal can retain in solution when it reaches the solid state, results in the insoluble body being rejected by the crystal during its formation and taking up its place between the boundaries of two crystal grains, there to exist as a separate entity whose resistance to stress will modify the manner in which the stress is sustained by the steel.

If the foreign body in itself and in its cohesion to the adjacent boundaries is stronger than the crystal, fracture will still take place through the crystal, but if it is weaker fracture will occur at the boundary occupied by the weaker body, provided its location is at the point of maximum stress. If the weaker body is not at the point of maximum stress it will, by failing to absorb its proportion of the stress, cause the badly distributed stresses to be thrown on the neighbouring crystals, usually piled up at a point on the boundary between the weaker body and the crystal. Slag particles or blow-holes in iron or steel act in this manner, and cracks are frequently found, on microscopical examination, to originate from such points. It will now be apparent why metals sometimes appear to break down at a point well within their elastic range when tested under alternating stresses of low intensity. The elastic range has at some point been exceeded as a consequence of some impurity, defect, or unfavourable crystalline arrangement.

The Notched Bar Impact Test.—The test-piece is 10 mm. square, and is provided with a notch so as to ensure its fracture at one blow across a predetermined plane.

The test-piece is clamped into a vice, and, by means of a pendulum-hammer falling with a known energy, a blow is struck of sufficient force to fracture it. The machine is provided with an idle hand moving across a scale which indicates the height to which the hammer has risen after fracturing the piece. The difference between the energy at the moment of impact and the energy expended in carrying the hammer past the lowest point of its swing is the energy absorbed in starting and carrying a crack to the point of rupture. The amount of energy so absorbed will depend upon the nature of the crystals and on the nature of the inter-crystalline matter.

If the material is very hard it will not deform, and therefore will absorb very little energy, and the energy absorbed will be that required to crack the piece; but if it be soft, just a little more energy may be absorbed in elongating the crystals. It will therefore be evident that to get a high impact value we require a material which is neither so hard that it will crack nor so soft that it will readily deform. Such material we refer to as tough, since it resists the shock stresses, causing cracking as a result of its high inter-crystalline strength, due to absence of impurities from the crystal junctions and to favourable crystalline arrangement, such as the fine grain produced by hardening at a suitable temperature, while, in addition, the material of the crystals themselves is stiffened to resist deformation by appropriate tempering and the stresses distributed over a large area in virtue of the inter-crystalline matter being as strong as, but no stronger than, the crystal. The fracture of a steel giving a low impact figure may be either crystalline, showing that fracture has taken place across the boundaries between the crystals, or may be raggedly deformed, due to great softness, while a steel giving a high impact figure will show a fibrous fracture of silky texture.

The remark that a steel has become crystalline through fatigue will therefore be seen to have no meaning, since all steel and iron is crystalline. The points to look at in a fracture are the size of the crystalline grains, which should be uniform and small in a hard steel, and in a soft steel broken by repeated bending should be in part at least fibrous as a result of the elongation of the crystals during fracture. The fibrous appearance is created during bending, so that if a nicked bar of good soft iron be broken by a blow so violent that the speed of propagation of the stresses is very high, a crystalline fracture may be exhibited, but the crystals should be small, and if again broken by less violent means they will draw out to the fine degree of attenuation which we call fibre. If the crystals are large they have been made so by some improper heat treatment, and not by mechanical strain alone, however often repeated.

Hardness Tests.—The standard Brinell hardness tester measures the hardness by the penetration into the metal to be tested of a 10-mm. diameter hardened-steel ball under a known pressure, usually 3,000 kilogrammes for steel and iron. The sample is deformed and the relative hardness is measured by taking the area of the depression from a measurement of its diameter and applying a formula in which the hardness is equal to the load over the spherical area of impression. It is usual to refer the diameter to a table to obtain the hardness number direct. The test-piece, polished to a smooth surface with a No. 1 emery cloth, is mounted on an anvil and by means of a screw brought into contact with the ball. By a small hand-operated oil pump the pressure is applied, and, after 15 seconds, released and the measurement made by a hand microscope with a millimetre scale mounted at the conjugate foci of the object and eye-piece.

This is one of the most simple and useful tests in the hands of the engineer; from it he can deduce the ultimate strength in tons per sq. in. with fair accuracy in a few minutes by multiplying the hardness number by a factor, usually 0.24 for mild steel. It is not necessary to use any particular machine for the purpose; any means of applying a dead load of 3,000 kilos. to a 10-mm. ball would give equally reliable results. Even with much smaller balls and loads interesting results can be obtained comparable among themselves for the same load and diameter of the ball. Excellent agreement with the standard machine may be secured with results from any other size of ball if the precaution is taken to adjust the load so that it is proportional to the square of the diameter of the ball.

The Scleroscope hardness tester consists of a hardened plunger ground to a point and mounted in a glass tube; by releasing the plunger it falls on to the surface to be tested and rebounds to a point on an empirically calibrated scale which indicates the relative hardness. This test, though not so generally applicable, is very useful for exploring surfaces for variations in hardness,

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such as case-hardened articles free from scale and having a smooth surface.

The Brinell hardness can be approximately related to the Scleroscope hardness for comparison by multiplying the latter value by six.

Stanton Repeated Impact Tester.—This machine was designed to determine the fatigue limit of endurance to repeated shocks, but has since been found useful in some cases for detecting comparative brittleness. The test-piece is 6 in. long by ½ in. dia., and is notched to a depth of 1 mm. around the circumference at the point of impact. The notch serves to concentrate the stresses in one plane.

Essentially it is a motor-driven hammer having a lever arm connected to the shaft. The end of the arm describes an elliptical course around the hammer, engaging and disengaging the latter at fixed heights so as to produce a blow whose striking energy can be varied at will. The rate of repetition of the blows may also be varied by suitable gearing. The test-piece is held on to a pair of anvils by a flexible gripping device, on which is mounted a toothed gear-wheel connected to a similar wheel on the shaft by means of a driving chain. The toothed wheel on the flexible grip is fitted with a tripping device, which comes into operation each time the test-piece is revolved through 180 deg., whereupon the rotation of the test-piece is arrested during the time required for the next half-revolution, and in that time it receives the blow. The number of blows is recorded on a counting device, and an electrical cut-out stops the machine when the test-piece breaks.

Sankey Alternating Bend-Testing Machine.—This consists of an anchoring block and a gripping block connected by means of a powerful flat spring. The test-piece, 6 in. long by ⅜ in. dia., has one end rigidly clamped in a grip and the other end entered into a levering bar, which is pressed by hand backwards and forwards within the angle prescribed by the stops. By this means the test-piece is bent to and fro until rupture occurs.

With each movement of the handle the grip also moves, but its movement is restricted by a spring. Since the stiffness of the test-piece determines the load required on the levering bar to effect bending, therefore the stiffer the test-piece is, the more the spring will have to be bent before its resistance is equal to that of the test-piece. The degree of bending the spring undergoes is communicated from the gripping block to a pencil carriage by a steel wire. The number of bends is thus recorded, and the effort for each bend is proportional to the length of the recorded stroke.

In conclusion, it should be remarked that these testing machines are nothing more than devices to determine some actual numerical value for properties which are daily met with by the apprentice engineer at the bench.

A first-class knowledge of the properties of metals can be obtained by bending, sawing, filing, and chipping the material and tracing differences to their probable cause.

A Method of Making a Spherical Casting with an Unvented Core.

The process described was used for making spherical floats of definite weight and about ⅜ in. thick.

1. The pattern, shown in Fig. 1, was in two halves dowelled at their centres. Its diameter was approximately 8 in.

2. The metallic core box, hemi-spherical in form, was braced with four stays to form a base. The dimensions, in millimetres, are shown in Fig. 2. It was arranged with four small bosses (*b*) for the purpose of forming in the core cavities, which will be dealt with under that heading.

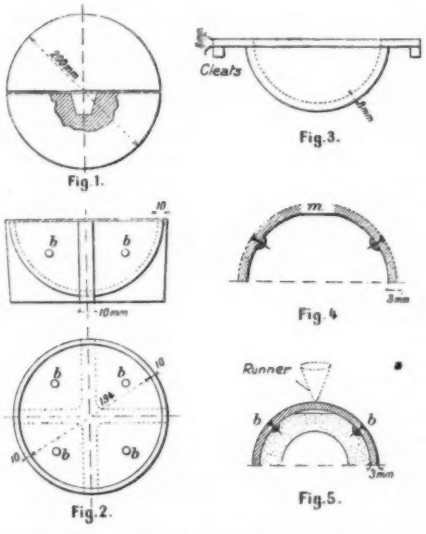
3. *Metallic Plate for Drying.*—These were fitted with four cleats. The same number of plates should be available as there are half-cores to make.

4. *Moulding.*—This was carried out in the ordinary way. Top pouring was used, and it was necessary to cut out a section of the core shown at (*m*) Fig. 4 on its upper surface beneath the runner, which allows of a larger space for the iron.

5. *Preparation of the Core Sand.* — Dried Nemours sand was sifted through a No. 12 sieve. It was then damped with very soapy water until it resembled the consistency of moulding sand. After thoroughly mixing it in a mill, it was re-sifted through a No. 8 sieve.

6. *Preparation of the Core.*—The interior of the core box was lined with a layer of sand, on which the pattern plate was printed. After withdrawing the plate, a powdered mixture of charcoal and burnt sand was sprinkled over the surface. The plate was re-inserted and the whole turned over. The top part of the core-box was taken off and four ½-in. sprigs were driven into the four specially prepared, hemi-spherical cavities (*b*), of 5-32 in. diameter. The sprigs were driven in and by using a template the heads were so arranged as to give the exact thickness of the casting.

In order to ensure that the sprigs firmly adhere to the sand, a drop of linseed oil was put in each cavity.



SHOWING METHOD OF MAKING SPHERICAL CASTINGS.

Before drying the cores, their surfaces were sprayed with soapy water. On removing from the stoves the cores were stuck together with a fine coating of dextrine and returned to the stoves for a few minutes to again dry. This left the core ready for the mould.

7. *The Mould.*—Dry graphite was sifted over the surface of the mould, and the excess blown off with bellows, clean water was then sprayed over the surface, and it was finally dried with a blow-lamp.

8. The finishing off followed normal practice. By using this method, the gas given off from the core is taken off by the central cavity. The sprigs act as supports.—"La Fonderie Moderne."

MAKING INGOT STRIPPING PLUNGERS.—A recent issue of "The Iron Trade Review" states that ingot stripper plungers are extremely difficult to cast, owing to the fact that the cylinders, 18 in. diameter, and 25 ft. or more long, have walls only 1 in. thick. Inasmuch as it is almost impossible to obtain a perfect core and then anchor it so as to prevent floating, the thickness of the metal often is reduced on certain sides, thereby weakening it and resulting in breakages. A plunger casting can be made much easier and of more uniform thickness by casting in three 10-ft. cylinders, instead of in one piece, and then welding the parts together by the thermit process. All three welds can be machined at the same time. As the outside of the cylinder must be machined in any case, practically no more machining is required than if the plunger were cast in one piece. Plungers have been welded successfully in this manner for the past ten years. By using this method smaller foundries can tackle much larger jobs than otherwise would be possible.

The Pattern Store.—I.

The pattern store, forming part of the progress organisation, is free from the control of the pattern shop, and all patterns entering and leaving the store can do so only when due authority is given. The storekeeper is a man who understands patterns, and who is quite competent to recognise the various appurtenances.

The layout of the pattern store is governed by (*a*) the class of goods manufactured, (*b*) the method of manufacture, and (*c*) the amount of space available. In regard to the class of manufacture, it is obvious that where very large patterns are featured the accommodation must be in accordance with the need, and so space is of vital importance.

The method of manufacture affects the internal system, for whilst in one factory goods are produced on the "massed principle," in another production is arranged on the "sub-assembly" basis; whilst in a third the idea of catering for customer's specific requirements means the handling of a large number of special patterns for a comparatively small number of castings.

The last method is certainly the most difficult for pattern storing, for there is no precedent to act as a guide, and although at any particular moment the store may be filled with patterns of comparatively small dimension—the lay-out of the store being in accordance—it is quite possible that in the very near future a quantity of much larger patterns will require accommodation. This being so, the store must be capable of expansion or contraction to cope efficiently with the varying demands, and the lockers or bins, or whatever may be in use for storage purposes, should be made adjustable, so that, without much trouble, they could be made to accommodate the varying sizes of patterns.

This is not at all difficult, for there are many makes of adjustable lockers, whilst, if desired these could be constructed at home, as is illustrated in Fig. 1. The main supports are made from steam piping, flanged top and bottom, and provided with clamps upon which the shelves rest These clamps can be moved to any position, so that at one time it is possible to have a number of shelves, say, 18 in. apart, whilst at another time the shelves are, say, 3 ft. apart, to accommodate larger patterns.

It is, however, in the recording that difficulty is experienced, and yet, in order for the pattern store to be worked efficiently, a card or other record is a necessity. Care must be taken in this connection, for an intelligible record is a real time saver. For this record to be effective, the location of the pattern must be shown upon the record, which means that each locker or bin must bear an identification mark.

The store may be laid out in bays, each bay comprising a number of bins. It must be remembered that some hundreds of patterns are involved, and it is impossible for the storekeeper to keep the whereabouts of each pattern in his mind. The average pattern store is a poorly organised department, for it seems to be somewhat beneath the notice of the management, and the attention it receives is but slight.

It is essential that when a pattern is demanded it must be produced, or its whereabouts stated. It must be possible for the storekeeper, by glancing at the record, to state precisely the bin which is occupied by the pattern (if it is in the store). If not in the store, it may be in the pattern shop, undergoing repair, or in the foundry, in use in connection with another order.

It may be observed that the pattern is called for either by name or number, and in the factory interested in various lines of manufacture it is necessary for the pattern store to be divided into sections, in order to facilitate handling. The pattern numbers would be in accordance with the type of manufacture, a bay being set apart for each distinct type. Thus the bays would be known as A, B, C, and so on, and the lockers or bins numbered consecutively 1, 2, 3, etc.

To each type of manufacture would be allotted a series of numbers, type A having numbers 1 to 100, type B 101 to 200, and so on. The number would then be definitely identified with the type, and it would be impossible for a pattern to be numbered A151 or B80. This has the effect of simplifying matters considerably, for it must be remembered that, in calling for a pattern, the prefix letter is often omitted. Assuming that pattern number 108 is called for, the storekeeper knows at once that it is for use in connection with type B manufacture, and will therefore be located in the bay marked B.

The card record is kept in the same manner, all cards referring to A type being together, etc. So, when the call is made for pattern number 108, the card bearing that number under section B is referred to, and it will be found that the bin location is number 20.

There are times when one pattern can be altered to do service for a number of different castings, and it will at different times bear different numbers, cross references being made upon the card to show the exact location. It may be that pattern number 108 is also used for number 130, reference

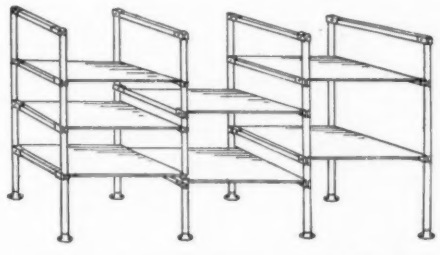


FIG. 1.—A SIMPLE PATTERN STORE RACK.

to this effect being made upon card 108. Assuming, then, that pattern number 130 is called for, reference to this card will show that the pattern to be used is number 108 (modified).

It is the simpler proposition to restore the pattern to its original state after use, which means that it would not be possible for pattern number 130 to exist in the store. To the storekeeper it would always be 108, the other number being effective after the pattern leaves the store. But though this may be desirable, it is by no means necessary, for the cross references upon the card will always enable the pattern to be located, no matter in what guise it may be.

No pattern is issued from store unless a written demand is received, this being in the form of a foreman's requisition, or an official order for castings, and the entry is made upon the record card before the pattern is surrendered. Likewise, no unauthorised person is allowed access to the patterns in store.

In many factories the pattern shop foreman is in control of the pattern store, but it cannot be said that this altogether conduces to efficiency. It may be urged that patterns are the direct concern of the pattern maker, but this is true only so far as work in process is concerned. Once the pattern is completed, and has passed inspection, it has ceased to be of interest to the pattern-maker, and until it is issued, upon demand, to the foundry the storekeeper is responsible for its safe custody.

To ensure accurate records being kept, it is essential that no one can interfere with the storekeeper, for the latter cannot do his work efficiently if an interested party can override him. The storage of machined parts is not controlled by the head of the machinery department which produced the parts, but by an independent storekeeper, and the same should apply to patterns. If the pattern-maker desires to recall a pattern he can do so by presenting a requisition, but he cannot be allowed to walk into the store and take what he requires, or even demand the same verbally.

It is observed that wood patterns are used to meet customers' special requirements, for the expense of making metal working patterns is not justified by the number of castings required. Wherever possible, these patterns should be adaptable, and in this connection an accurate record is necessary, otherwise new patterns are

continually being made, and a huge stock of obsolete patterns created. It should be the aim of the storekeeper to keep this stock as low as possible, and with this end in view he should make a periodical return of such patterns, to ensure utilisation by means of adaption.

Every pattern received into the store should be vouched for by the inspector; this also applying to patterns returned from the foundry after use. This means that no pattern is received into store in a bad state of repair and that the foundry can ensure every pattern demanded being ready for use. Too much time is lost, and too many "wasters" made, by failure to observe this rule, for wood patterns will not stand much hard treatment, and frequent overhauling is necessary to keep them in good condition.

To ensure this being done, all patterns, after use, should be sent to the pattern inspector, who will put them under examination, passing those which are good to the store and those which need repair to the pattern shop. For recording purposes, a list of those sent for repair should be sent to the storekeeper, who makes the necessary entry upon his card.

If the storekeeper is responsible for the collection of patterns from the foundry, a portion of the store may be set apart for uninspected patterns, it being understood that these are not considered as being in store. A notification is sent to the inspector, and the patterns are not removed until the necessary authority is given. This would apply also where the castings are made outside the factory; for obviously the patterns, upon being returned to the factory, would be forwarded to the pattern store

Sweeping Elbow Cores.

Cores for pipe bends, especially large sizes, and smaller sizes where only a few are required, generally are swept on plates with suitable frames and strikles.

Having decided on the total length of the core from end to end, including the prints, a pattern is made from which one or two iron plates are cast. If it is necessary to dry both halves of the core the same night two plates are necessary. Sometimes

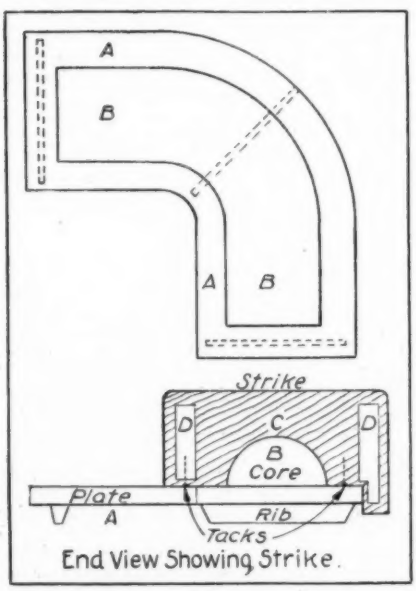


Fig. 1.—Usual Method of Sweeping Elbow Cores.

only one-half of the core is dried the other half being built upon it afterwards. Even when two plates are required on account of a non-reversible core, that is one in which the two halves will not match when one is placed on the other for pasting, one pattern is sufficient. The only precaution to be observed is that one half of the core is made on one side of the plate and the other half made with the reverse side of the plate turned up. When plates are provided with ribs, two patterns are necessary.

In Fig. 1 *A* represents the plate; *B* the core, and *C* the strikle. The latter is cut from a piece of board ranging in thickness from ⅜-in. to 1 in., depending on the size of the core. The semi-circular gap in the strikle determines the diameter of the required core. It is strengthened if necessary by two battens shown at *D D*. The edges of the semi-circle are bevelled which enables the strikle to work more smoothly and correctly over the body of sand forming the core.

A few flat-headed tacks or nails should be driven in flush with the face of the strikle which comes into contact with the plate to prevent it from wearing away and thus altering the shape of the core.

The coremaker places enough material on the iron plate to form one half of the core. He rams it firmly and shapes it roughly by hand to correspond approximately to the required shape. The sweep, with a shoulder held in close contact with

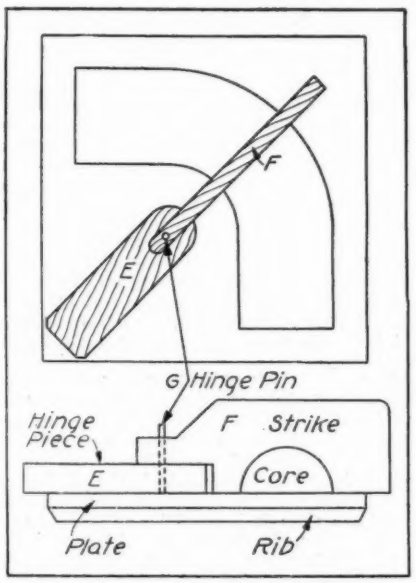


Fig. 2.—Improved Method of Sweeping Elbow Cores.

the edge of the plate, is then drawn from end to end. Small inequalities are made up by hand and the sweep passed over the face several times until the shape is perfect.

The plate, the sweep and the material forming the core are shown in the end view, Fig. 1. The position of the tacks on the edge of the sweep also are indicated.

An improvement on this method is shown in Fig. 2. In this method it is not necessary to make special drying plates. Any plate large enough will answer the purpose. The hinge piece E is simply a plain piece of board provided with a ½-in. hole at one end and clamped to the plate at the other end. The strikle is also a plain piece of board provided with a ½-in. hole near one end which slips over the dowell pin in the hinge piece. This strikle swings in the arc of a circle, and forms the curved portion of the core. The straight part is formed by a strikle similar to that shown in Fig. 1 and drawn along the edge of the plate at the upper and lower edge.—Extracted from *The Foundry*.

DESIGN OF FOUNDRIES.—In a Paper read before the American Foundrymen's Association at the Columbus meeting Mr. J. H. Hopp stated that sand can so greatly reduce a given day's profits, despite its comparatively low cost, as to more than make worth while the separate storage of each truck bought. Sand should be protected against the weather, even if it has to be entirely enclosed. "If those to whom this method does not appeal would record the amount of scrap produced by frozen or too wet sand, they would agree that heated buildings for sand storage are essential."

An Electrically Operated Foundry.

One of the latest companies to start with the definite purpose of specialising on the production of small intricate castings is the Emery Steel Castings Company, Baltimore, U.S.A. From the following description of the equipment which this company has installed, it may be seen that its nature will have a tendency to hold the company to its original intentions.

The characteristic of this equipment is that electrical heat is used in all cases. Beginning with the electrical melting furnace, the metal is cast in moulds dried in an electrical oven and annealed in an electrical annealer. Heavier castings which could be made from a steel inferior to electric furnace steel, and not requiring annealing nor dried-sand moulds, would render these electrical furnaces and ovens superfluous. The Electric Furnace Construction Company, Philadelphia, the American House of Messrs. T. H. Watson & Company, of Sheffield, which built the core oven and annealing furnace, guaranteed the oven to bake 13 lbs. of cores per kilowatt hour. It has been found in actual practice that even with intermittent operation, 18 lbs. of light cores are baked per kilowatt hour. Larger cores require more power for baking, and as the plant is new, an absolute standard of power consumption has not been determined.

It was decided to start on a small scale and work out the organisation necessary to produce high grade castings. A 1-ton electric melting furnace was installed. With such electrical equipment, it is essential that current be obtained at all times.

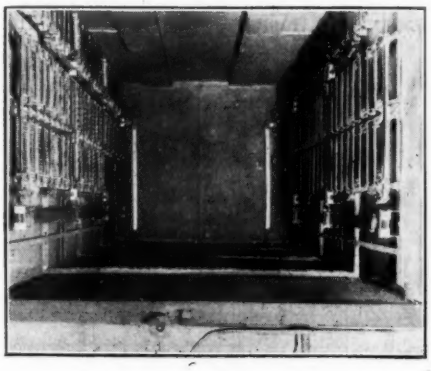


Fig. 1.—The Drying Stove.

Therefore, to avoid shutdowns owing to the power being off, two lines were run to the foundry from two distinct feeders which are in no way related to each other. The melting furnace has a rated capacity of 1 ton. A spare roof is kept in a pit near the furnace, covered with a wood platform. Eight-inch carbon electrodes are used at present. The management saw little choice between the carbon and the graphite electrode. Figures secured did not show a marked advantage of cost in either of the two types of electrodes.

So far, only two heats are taken off each day. Each heat requires about two hours. When greater production is required and several heats are made each day, the efficiency of the furnace will be increased considerably. Metal is shanked directly from the furnace for pouring into the moulds, which are arranged on the floor immediately around the furnace.

All the moulds are dried. It is the opinion of the management that small moulds should be dried, whereas a mould for a casting weighing 100 lbs. or more would be made in green sand. A local silica sand has been found which has a fine uniform grain, and when mixed with a small proportion of clay and molasses water, together with sea-coal facing, forms a satisfactory mould.

The moulding and coremaking machines to be finally used have not been determined. The pattern equipment, of course, will be determined by whether the orders are for repetition work. So far, the volume of work has been mostly on small orders, but these orders have come from many parts of the country. Even one English firm which has a branch in this country found the Emery Company could make a casting which it was unable to procure in England, and has ordered a number of these castings for its English plant.

Electrically Heated Oven.—As may be surmised, all the moulds are quite small and comparatively easy to dry. However, it is highly important that they be dried uniformly, and that cores or moulds

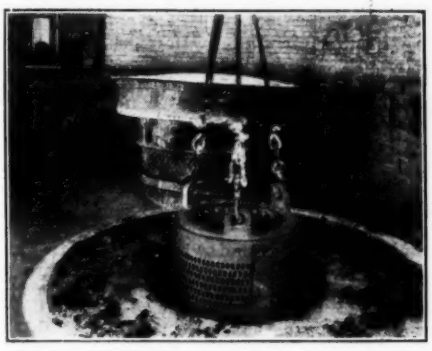


Fig. 2.—The Annealing Furnace with Cover Removed.

in one part of the oven are not baked harder than those in another section. This was one of the reasons which induced the Emery Company to instal an electrical drying oven. Another reason was oil could not be secured satisfactorily when the foundry was started, and it is estimated that the cost of operation with either gas or oil would be as expensive as with electricity. On a small oven the expense of an attendant to watch the burner and temperature when firing with either gas or oil is high compared to the amount of moulds dried; whereas, with the electric heating no attention is necessary after the car has been put in the oven and the doors closed. Coal or coke probably would be cheaper, but it was questioned whether the temperature throughout the oven could be kept as constant or as uniform when using either of these fuels.

The inside of the oven is shown in Fig. 1, which indicates the type of resistors used. These resistors consist of resistance ribbon wound on insulators and divided into three circuits. One circuit consists of the two rows of coils at the top on the side of the oven. Another similar circuit is on the opposite side, and the third circuit is composed of the lower coil on the two sides of the oven. The walls, roof and door are well insulated to prevent loss of heat. The rack of moulds and cores is placed in the oven on a special spring-suspension truck, the bed of which is lifted mechanically.

The length of time required is being determined by experience, and the oven will not be operated

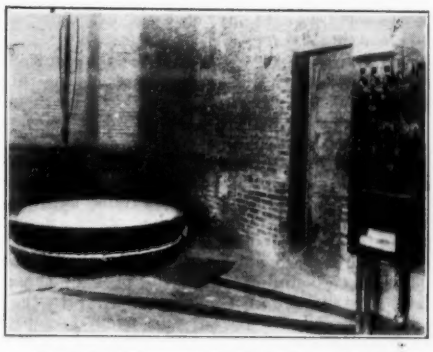


Fig. 3.—Showing Soaking Pit, Control Panel and Annealing Furnace in Background.

on the most economical basis until the correct time to allow the moulds to bake is determined.

An electrical temperature regulation device is attached to a thermocouple in the oven. The temperature is regulated by setting two pointers by a temperature scale on the upper face of the instrument. These pointers may be set as close

together as desired, but the closer they are set the more frequently will they throw off and on the current, because when the temperature rises to the figure indicated by the pointer at the higher point on the scale, the circuit breakers will be thrown and the circuit will remain broken until the temperature of the oven falls to the point indicated by the lower pointer when connection again will be made. The Emery Company sets the pointers at 232 and 243 deg C. Then when the temperature of the oven reaches 243 deg. C. the circuit is broken and not connected until it falls to 232 deg. Were the pointers set only 5 deg apart, the circuit would be connected as soon as the temperature of the oven fell 5 deg.

Below the circuit breakers is a lamp. This lamp burns as long as there is power at the panel. Should the power go off at any time, the lamp will indicate this fact to the foreman. Without a free circulation of air, the moisture from the cores would remain in the oven, and, with a damp atmosphere, it would be difficult to dry the moulds thoroughly. A fan, direct connected to a small electric motor, is provided to overcome this. The efficiency of the oven depends on the operation of this fan. If too much air is passed through the oven, the cooling effect is excessive; while if not enough air is circulated, the cores will dry slowly. Another device for assisting the circulation of the air in the oven is the sheet-steel plate placed at the lower portion of the resistors, as shown in Fig. 1. This forms a draft, and also protects the moulds from the direct radiation of heat from the resistors.

Moulds are brought from the drying oven to one corner of the foundry near the melting furnace, and placed on boards for pouring. This is not an arduous task, and two men teem the entire heat in half an hour. The foundry clerk marks the pattern numbers of the castings in each on the mould, so that he may know what is contained if it is not poured. Two sand mixers of the Muller type are used. One mixes the facing sand and the other mixes the backing sand.

Castings are annealed in a new pit-type electric annealing oven designed and patented by Mr. F. W. Brooke, of the Electric Furnace Construction Company. This style of oven was selected because it is desired to secure the annealed casting as free from surface oxidation as possible and to conserve floor space. The oven shown in Fig. 2 consists of a pit 40 in. in diameter inside the lining of firebrick, and 5 ft. deep. The heating units are resistance ribbon wound on insulators built into the roof, and were secured from the General Electric Company. This pit is closed by a brick-lined cover. The cover is secured by a hinge at the rear, and is raised by an air hoist attached to the eye shown at the front. Heat is controlled automatically by an arrangement similar to that described for the drying oven. However, a different instrument is used for throwing the current on and off. This instrument, shown at the bottom of the panel in Fig. 3, also records the temperature on a chart, which may be seen extending down from the bottom.

The instrument is built on the potentiometer system, in which no current flows from the thermocouples placed in the annealer, but the temperature at the two points is indicated by measuring the difference in potential at the ends of the two wires from each thermocouple. This system eliminates a possibility of trouble from a change of resistance in the circuit. Having two couples, the one near the top and the other near the bottom of the annealer, the temperature of the oven at these two points is recorded. The desired temperature is indicated on the back of the panel in the instrument in a manner similar to the way it is regulated for the drying oven. At present the temperature is automatically maintained between 880 and 900 deg. Cent. The contactors and circuit breakers may be seen on the panel above the recording instrument. The kilowattmeter is shown at the left on a separate panel. A record is kept of the time in and out, the power consumed and the anneal number, as well as of the weight of the charge.

The annealing oven has a rated capacity of half a ton. The furnace is comparatively cool when the charge is put in, and four hours are required for the anneal. After the correct length of time has expired, the cover is let down in the pit over the cage containing the castings, one of which is shown at the centre, Fig. 2. Slots in the top of the cover allow the three lugs on the cage to extend through. A chain is attached to eyes in the lugs on the cage, and the whole is lifted from the pit by the air hoist and transferred to the soaking pit close by. The cover is removed and the lid of the pit closed, swinging on a hinge and supported by a counterweight shown above. The castings are allowed to remain in the cooling pit the same length of time as is required for the anneal. When taken from the soaking pit the castings are below 405 deg. Cent. The principle of the soaking pit is to enable the electrically heated portion of the furnace to operate continuously.—Extracted from "The Iron Trade Review."

Piping in Aluminium Ingots.

By JUNIUS DAVID EDWARDS and HAROLD T. GAMMON.

Before considering the problem of the pipe it will be well to consider the volume changes which occur on freezing. In Fig. 1, Curve *A*, is shown the relation between temperature and specific volume, which is the volume to millilitres per gram of pure aluminium. Starting with the liquid metal, the contraction on cooling is slow and uniform until the freezing point is reached; at this temperature a large contraction in volume takes place during the solidification. The solid metal then contracts slowly, but at a somewhat different rate from the metal in the liquid state.

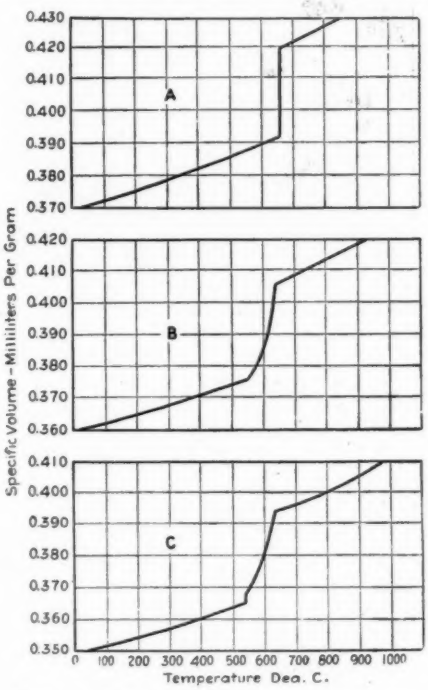


FIG. 1.—RELATION BETWEEN TEMPERATURE AND SPECIFIC VOLUME.

Curve *B* shows the same relations for an alloy of aluminium with 4 per cent. of copper. The most characteristic difference to be noted is that solidification no longer takes place at constant temperature, but over a considerable range of temperatures, amounting in this case to approximately 100 deg. C. Curve *C* shows the change in specific volume of the alloy of aluminium better than in the preceding case, because part of the solidification takes place at constant temperature. The 8 per cent. copper alloy contains approximately 15 per cent. of the eutectic mixture when it has cooled to a temperature of 540 deg. C., and this eutectic freezes at constant temperature in exactly the same way as a pure metal. These three curves show the characteristic volume

changes on freezing of the pure metal and two of its important binary alloys.

Briefly, the formation of the pipe in casting an ingot takes place in somewhat the following manner: The metal which is in contact with the walls of the mould cools to the freezing temperature first, and there solidifies to form a solid shell, which grows in thickness by the continued solidification of the metal. Because there is a contraction in volume of the metal upon solidification, the level of the liquid contained within this shell of frozen metal is continually lowered during the course of the freezing. If no additional metal is supplied during the freezing process, a conical-shaped cavity known as a pipe is formed. The main function of the gates and risers is to supply the metal required to keep the mould completely filled during the solidification and consequent contraction of the metal contained in it. With reference to Fig. 1, Curve *A* shows that the contraction on freezing in the case of pure aluminium is about 6.6 per cent., and consequently 6.6 lbs. of aluminium must be fed into the casting from the gates for every 100 lbs. of casting. In the case of the 4 per cent. and 8 per cent. copper alloys the contraction upon freezing is of approximately the same magnitude.

The volume of the pipe is not, however, necessarily equal to nor proportional to the contraction upon freezing. In the case of pure aluminium the two are very nearly alike. That this is nearly so comes from the fact that the shell first formed in the casting of the pure metal is quite rigid, and the contraction during freezing necessarily appears in the form of a central cavity. In the case of the alloys, however, the solid which separates during the first part of the freezing process is a network of crystals more or less interpenetrated by liquid. This mixture may be quite plastic, and the shell which first forms in the mould is not so rigid as in the case of the pure metal. This is of advantage in casting practice, because it permits the casting to adjust its form somewhat upon cooling without straining the cores or other fragile parts of the mould. As a result, the mixture of partly frozen metal within the mould behaves as if it was still liquid for a considerable interval of temperature below the commencement of freezing. As a consequence the volume of the pipe which is formed with the alloys is less than is the case for the pure metal. The apparent volume of the pipe may also be reduced in some cases by the formation of a porous structure at the top of the ingot, gate or riser where the final freezing occurs. This happens if the network of crystals at the surface possesses sufficient rigidity to allow the eutectic to withdraw from between the crystals during its solidification, thus leaving void in this part of the metal. Part of the pipe is then disseminated and concealed within the body of the metal.

Experimental Method.

The following method was employed to determine the relative piping effect with different metals: A graphite crucible having a capacity of approximately 225 c.c. was filled with slightly more than that volume of molten metal, after which a hot iron plate was pressed down upon the surface of the crucible and the metal. The plate forced out the excess metal so that the crucible contained exactly its known volume of metal at that average temperature. After the metal had solidified the ingot was removed and the exact volume of the pipe was determined by filling with mercury and then weighing the mercury. A piece of paraffin-coated paper with a straight edge was wrapped tightly around the ingot and fastened in place in order to sharply define the upper edge of the pipe in case it was irregular or not level. An attempt was made, by controlling the pouring temperature, to have the metal freeze sharply at the edge of the crucible, so that the volume of the pipe might be sharply defined. This was a difficult condition to obtain with most of the alloys. The pipe in the ingot is measured at room temperature, and is therefore smaller than it was at the freezing point in the solid state. The correction for this has been calculated from the solid shrinkage of the metal, because of the shrinkage of the metal and the volume of the pipe then expressed as a percentage of the volume of the mould, which volume was the original volume of the ingot before cooling.

The solid shrinkage, which is the relative change in volume of the solid metal in cooling from the freezing point to room temperature, was determined by casting in a sand mould a bar about 2 ft. long. The ends of the mould were formed by two graphite blocks which were rigidly held a known distance apart by steel plates; these were so arranged that the heat from the metal did not cause any appreciable expansion of the steel plates before the metal in the mould had set. The space between these graphite blocks was filled with solid metal at the freezing point. Knowing the distance between the graphite blocks and the length of the bar when cold, the shrinkage expressed in inches per foot of original length may be readily calculated.

The results of a series of measurements on the volume of pipe and the solid shrinkage of aluminium and some of its alloys with copper are given in Table 1.

TABLE I.—*The Piping Effect in Aluminium and its Alloys.*

Composition.	Volume of crucible, ml.	Pouring temp., Deg. C.	Solid shrinkage ins. per ft.	Corrected volume of pipe, ml.	Piping effect, per cent.
Al 99.4% ..	239	843	0.21	18.3	7.7
Al+ 4 Cu..	223	705	0.19	10.0	4.5
Al+ 6 Cu..	223	705	0.18	9.8	4.4
Al+ 8 Cu..	239	705	0.18	9.1	3.8
Al+10 Cu..	223	705	0.17	7.1	3.2
Al+12 Cu..	223	705	0.17	7.0	3.1
Al+31 Cu..	223	705	0.15	12.9	5.8

The observed piping effect with the aluminium was 7.7. per cent. and with the 8 per cent. copper; aluminium alloy was only 3.8 per cent. This at

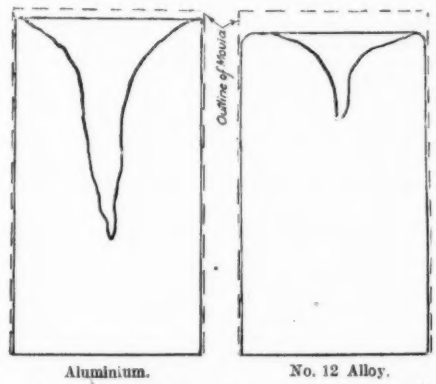


FIG. 2.—VERTICAL SECTIONS THROUGH ALUMINIUM INGOTS.

first appears anomalous, in view of the fact that the solidification shrinkage is approximately the same in both cases (6 to 7 per cent.). It may be illustrated more clearly by reference to Fig. 2 where the experimental ingots for the pure aluminium and the 8 per cent. copper alloy are shown in section. It will be noted that the ingot of No. 12 alloy is shorter than the aluminium ingot and that the upper edges are very much rounded off, whereas in the aluminium ingot the metal has frozen sharply at the edge of the crucible. In the aluminium ingot the total contraction during solidification is represented by the volume of the pipe. In the alloy ingot part of the contraction has been taken up by a readjustment of the shell initially formed in the mould, a fact which is attested by the appreciably shorter length of the alloy ingot. This difference in length is more striking when it is considered that the linear shrinkage of aluminium after solidification is greater than that of No. 12 alloy. In the case of the ingot of No. 12 alloy shown in the figure, its average length was about 11.2 cm., whereas it should have been nearer 11.7 cm. in length if the crystals had remained in place as they solidified at the walls. When allowance is made for this fact, it is found that the total solidification and liquid shrinkage was about 6.3 per cent., which is in fair agreement with the contraction indicated by the graph, making due allowance for the approximate nature of the measurements made on the ingot.

The piping effect gradually decreases with increase of copper, but there is very little decrease

noted beyond 10 per cent. However, the sample containing 31 per cent. copper and which is very nearly of eutectic composition shows a larger pipe than some alloys of lower copper content.

The volume of pipe formed in any given alloy is a complex function of the following factors:—(1) The percentage contraction during solidification; (2) the rate of solidification during the freezing interval; (3) the temperature range of the freezing interval; (4) the size and form of the mould and probably some other conditions. Because the volume of the pipe is dependent on conditions external to the metal, it is not even certain that different alloys would give the same relative piping effect in one mould that they would in another. It is, accordingly, impossible to describe piping as a definite property of a metal. The contraction upon freezing is, however, a perfectly definite property which can be defined and measured and is the fundamental cause of piping. The values given in the table should therefore be considered in the light of this discussion whenever any use is to be made of them. It should also be borne in mind that the casting properties of a metal are not solely defined by the piping effect. It is only one important factor to be considered. A low solid shrinkage, for example, is of course very desirable in a casting alloy in order that the strains which are set up in a casting on cooling may be reduced to a minimum.—Extracted from a recent issue of "Chemical Metallurgical Engineering."

Inspection of Malleable Castings.

According to a recent issue of *The Foundry*, four travelling inspectors have recently been appointed by the American Malleable Castings Association to further the system established to insure uniformity of product from associated foundries. These inspectors, who are attached to the laboratories of Enrique Touceda, Albany, consulting engineer of the Association, will call upon the plants of all of the members at intervals, where they will be given free access to the castings in progress, and will inspect the product as it comes from the annealing ovens, breaking and testing castings where advisable. They will report directly to the office of the consulting engineer. When in the plants of members of the Association they will exercise a general supervision to insure proper sampling of heats.

A method has been devised to govern annealing practice and to eliminate the chance of under-annealed castings. Five test wedges are to be placed in each charge annealed. One of these will be placed in the bottom of the stand situated in each corner of the oven, and the fifth in the centre of the oven. In this manner they will be placed where the temperature might not reach the high point desired. The five wedges in each batch will be marked to indicate their position, and wired together to await the inspection of one of the representatives of the laboratories. The inspectors will break the test wedges transversely and examine the fracture for evidences of conditions which should be corrected. These test wedges will supplement the test bars which are made from each air-furnace heat and sent to the laboratories for examination.

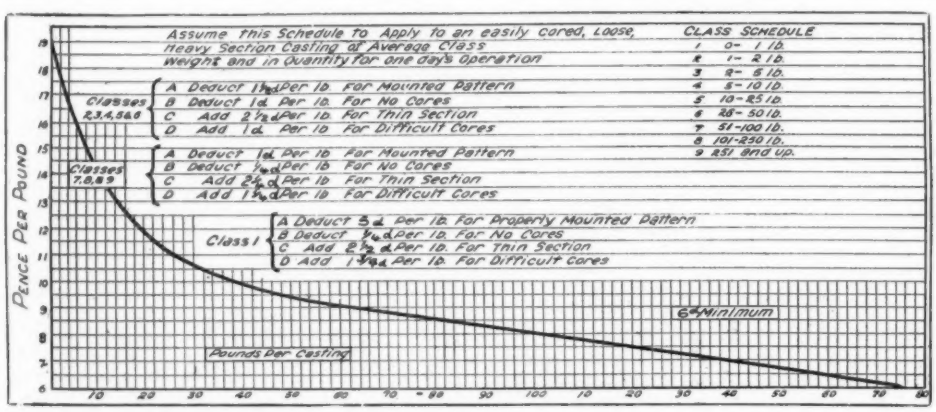
Steel Castings Selling Chart.

A useful chart was recently published by *The Foundry* to help salesmen to quote for castings without reference to the costing department of his works.

A new American steel company, before it started operations estimated its costs for making electric steel castings and then drew up a chart for the benefit of its salesmen. This chart enables the salesmen to determine easily the selling price of any casting. The curve is based upon an easily-cored, loose, heavy-section casting of average class weight and in quantity for one day's operation. Of course only a small number of castings would fall under this description, but allowances are made for different contingencies.

Castings are divided into nine classes. Class 1 covers all castings up to 1 lb. in weight; Class 2 extends to those weighing 2 lbs.; Class 3, to 5 lbs.; Class 4, to 10 lbs.; Class 5, to 25 lbs.; Class 6, to 50 lbs.; Class 7, to 100 lbs.; Class 8, to 250 lbs.; and all castings above this weight are included in Class 9.

These classifications serve two purposes. The one purpose is to establish divisions for adjusting prices from the standard scale. As may be noted on the chart, two causes are marked for an added charge and two permit reductions. In Class 1 a deduction of 5d. per lb. is allowed for a *properly* mounted pattern, while in Classes 2, 3, 4, 5 and 6 1½d. per lb. reduction is allowed in the price when mounted patterns are furnished. For the larger castings, Classes 7, 8 and 9, a reduction of only 1d. per lb. is allowed in such a circumstance. Another occasion for a reduction is when no cores are needed. In Classes 1, 7, 8 and 9 this amounts to a ½d. a lb., while in Classes 2, 3, 4, 5 and 6 a reduction of 1d. a lb. is made. Additional charges are made when the castings have thin sections and when difficult cores are required. An increased


Assume this Schedule to Apply to an easily Cored, Loose, Heavy Section Casting of Average Class Weight and in Quantity for one day's Operation
CLASS SCHEDULE
1 0- 1 lb.
2 1- 2 lb.
3 2- 5 lb.
4 5- 10 lb.
5 10- 25 lb.
6 25- 50 lb.
7 51- 100 lb.
8 101- 250 lb.
9 251 and up.
Classes 2,3,4,5&6
A Deduct 1½d Per lb. For Mounted Pattern
B Deduct 1d. Per lb. For No Cores
C Add 2½d Per lb. For Thin Section
D Add 1d. Per lb. For Difficult Cores
Classes 7,8,&9
A Deduct 1d Per lb. For Mounted Pattern
B Deduct ½d Per lb For No Cores
C Add 2½d Per lb For Thin Section
D Add 1½d Per lb For Difficult Cores
Class 1
A Deduct 3d Per lb. For Properly Mounted Pattern
B Deduct ½d Per lb. For No Cores
C Add 2½d Per lb. For Thin Section
D Add 1½d Per lb. For Difficult Cores
64 Minimum
Pence Per Pound
Pounds Per Casting

charge of 2½d. per lb. is made for castings in classes up to and including Class 6 when the sections are thin. For Classes 7, 8 and 9, the increase is only 2½d. Difficult cores add ¾d. per lb. to the price of castings in Class 1 which have difficult core; the addition in Classes 2, 3, 4, 5 and 6 is 1d., and in Classes 7, 8, and 9 it is 1¾d.

The second purpose served by this classification is in cost accounting. From the start of the foundry, costs of castings were kept according to order number, where possible, and from these costs information is being secured to determine the exact costs of the different classifications and grades. As any changes in the amounts to be deducted or added are found desirable they are noted on the chart. However, when a change in the cost of operation or of materials is made which affects the entire curve a notation is made on the chart, such as, "deduct 1½d. per lb., beginning June 1." Should the relation of charges for the different weights be ununiform an entire new chart would have to be made. This chart is of great assistance to the salesmen as with continued accumulation of cost data it will be founded on exact calculations.

The Erosion of Bronze Propellers.

At a recent meeting of the London Section of the Society of Chemical Industry Dr. O. Silberrad reviewed researches which he had made, in conjunction with Messrs. Charles and P. R. Parsons, during the twelve years from 1908 to 1920, which have led to the adoption of the type of bronze alloy for the manufacture of high-speed propellers. This work has resulted in the discovery of the erosion-resisting alloys that are now used throughout the world for the propellers of high-speed ships, and the researches in question have proved incidentally that the deterioration of these propellers is due to mechanical erosion, brought about by a combination of frictional rub with the action of water broken by evacuated spaces in which no air is present. Quite recently the subject has again been brought into prominence through the investigations of a sub-committee of the Board of Inventions and Research. The conclusions arrived at by this Committee, on the whole, confirm the author's observations that the deterioration is primarily due to mechanical causes. As regards chemical action, this Committee observes that there is no evidence of this, which is also in accord with Dr. Silberrad's investigations.

The first ship equipped with propellers cast in the new type of alloy was the "Mauretania." These propellers were made because the first propellers put upon this vessel, which were of the old type of bronze, were worn out in three months. The propellers of the new alloy were fitted in January, 1909, and at the end of six months their condition was reported to be as perfect as when they were first installed.

The author has come to the following definite conclusions:—(1) Chemical action is a negligible factor in the erosion of bronze propellers; (2) galvanic action does not appear to come into play at all; (3) the presence of dirt in the castings has only a slight detrimental effect; (4) the true cause of the deterioration is mechanical, and is therefore properly termed erosion, the determining factors being: (a) the frictional rub of the water, (b) the impinging on the propeller blades of water broken with evacuated spaces, which subsequently collapse on the propeller blades, both of which conditions are more liable to arise in high-speed ships or propellers moving at a high velocity.

It has also been established that, where alloys containing α crystals are exposed to this action, these α crystals are liable to deformation unless they are wholly embedded in β crystals, from which it would appear that a bronze composed essentially of a β structure is best calculated to withstand the deterioration under consideration. At the date when these researches were commenced—namely, 1908—alloys consisting essentially of copper and zinc were regarded as being mechanically unsound, and the research, therefore, turned on the problem of discovering suitable additions to copper-zinc alloys of the manganese bronze type, which would change them from essentially α alloys to those of β structure without impairing their physical properties in any way. From the results it was observed that, although a copper-zinc brass of purely β structure is not a satisfactory alloy, nevertheless, alloys quite equal in mechanical properties to the old-established α bronzes can be produced by introducing small quantities of aluminium, manganese, iron, etc. Having thus established the practicability of producing improved erosion-resisting alloys of this type, their further development and application followed as a matter of course, and such alloys are now used through the world for the manufacture of propellers for high-speed ships.

Discussion.

MR. A. T. QUELCH said he could confirm all the author had said with regard to erosion in bronze propellers being caused mechanically. This was specially brought to his notice in the case of the propellers of the "Swift," one of the first destroyers designed for 36 knots. Altogether twenty-six propellers were made for that ship, and most of them were returned to the makers after the trials, and from his examination of them he was interested in the very curious manner in which the area of the eroded part moved about as the design was altered, a fact which conclusively proved that it was a mechanical cause, because, if the action had been a chemical one, the whole of the surface would have been affected, and not one particular part. With regard to the question of dirt in the castings, the Admiralty at one time thought that by putting in geared turbines, and reducing the speed of the propellers, all trouble with propellers would be done away with. There was, however, serious erosion in the propellers of some of these destroyers, and it was found that the greater proportion of the so-called erosion was dirt washed down by the propeller, due to the design of the propeller. Unfortunately, the foundry was rather the kitchen-maid of the engineering industries. The engineer got out his designs, and did not consider whether they were good or bad from the founder's point of view. In this particuar case the propellers were of such a large area that, in order to get them on the boss, they had to overlap the top and bottom of the boss. As the propeller was cast with the driving face downwards all the metal, containing a large proportion of zinc, which entered the boss had to run down hill, and there was a considerable disturbance of the whole of the metal by oxidation of the zinc, and the production of a large amount of oxide. Consequently, there was not a very great chance for the dirt to get away, and the greater proportion of the erosion in this particular case was due to dirt. Another cause of erosion in this instance was the design of the A bracket, which had the effect of throwing a jet of water on to the propeller, with the result that grooves were eroded in the blade 1¼ in. deep. He would like to ask the author as to the size of crystals in the beta structure, which could be produced by adding aluminium, manganese, iron, etc., to the ordinary copper-zinc alloy, because it seemed to him that the size of the crystals must have a very considerable influence on the mechanical properties. There was no doubt as to the advantages to be obtained with the beta alloys referred to by the author, but, as regards the propellers of the "Mauretania" and "Lusitania," he thought they were inclined to give a little too much credit to the beta alloy. The original propellers on both these vessels were of the built-up type, *i.e.*, they were three-bladed propellers, with the blades cast separately and bolted on to the boss, and the bolting of these blades did not make a very near job. When the new propellers were fitted they were solid, and in comparing the results it was a little difficult to know how much credit should be given to the alloy and how much to the design of the propeller. He was not at all sure that the whole trouble with erosion had been completely got over, because it still existed to some extent, but the difficulties were very great owing to the arduous conditions under which propellers worked.

DR. SILBERRAD said that he had not gone into the question of the size of crystals in the paper—first, because it was not a metallurgical paper, and, secondly, because he did not feel equal to go through the metallurgical notes which had been made during the twelve years covered by the paper. Some of the alloys, however, produced enormous crystals, and in one series the crystals were 2 in. long, and weighed anything from 2½ to 5 lb. Such an alloy was not easily broken with one blow, but it crumbled away under repeated tapping over a period.

MOTOR CYLINDER IRON FROM ELECTRIC FURNACE.—The Electric Furnace Construction Company, Philadelphia, the American house of Messrs. T. H. Watson & Company, of Sheffield, announces the starting up of a Greaves-Etchells electric furnace at the Holmes Foundry Company's plant, Port Huron, Mich., for refining and superheating molten cupola metal. Results obtained have been satisfactory and encouraging. It has been found possible, by short treatment in this electric furnace, to increase the fluidity of the metal and to largely eliminate sulphur. The cupola iron contained 0.12 per cent. average sulphur, and the finished product showed only 0.023 per cent. sulphur. Time taken was about 40 minutes. Charges of cold scrap have also been run, consisting of 80 per cent. cylinder scrap and 20 per cent. iron borings. Sulphur in final product from the cold melted heat was reduced to 0.013 per cent.

XUM

Institution of British Foundrymen.

LANCASHIRE BRANCH.

At a recent meeting held at the College of Technology, Manchester, Mr. W. H. Meadowcroft presiding, Mr. S. Langton, of Stockport, read a Paper on the "Casting of Brass and Aluminium."

The Chairman said the casting of aluminium was a most fascinating subject for a foundryman. It was an illusive metal and one which gave all sorts of results. He thought that came about largely through inexperience, and Mr. Langton's remarks should be helpful, as he spoke from a long and extensive experience.

Foundry Practice and Problems of Non-Ferrous Metals.

Although the predominating membership of the Institution must be interested in iron founding, any foundry problem should be of interest to all members, whether it be in iron, brass, or aluminum.

This is not a scientific treatise on aluminium, but rather a summary of experience gained as a founder of aluminium since its early days, when it was found that it could be used with advantage for commercial purposes in displacing iron and brass, owing to its lightness relative to those metals. The specific gravity of pure aluminium is 2.58, as against that of iron being 7.2, therefore there is a great advantage in aluminium where lightness is of primary importance, such as the motor car industry and for aeronautical purposes.

It was in the year 1854 that Deville, a Frenchman, first produced aluminium in its nearly perfect purity, and he was so struck by its future possibilities for industrial purposes that he decided to further his studies on a much larger scale. He had a medal struck in aluminium and presented it to Napoleon III., who had such faith in the metal that he authorised experiments to be carried out on a large scale, at his own expense, with a view to applying this metal to the armour of his soldiers. It was, however, too early for this to materialise.

Aluminium was a very expensive metal in its early days, and in the early part of 1856 was as much as £22 sterling per lb.; from then it has declined in varying stages to as low as 6d. per lb., its present price being about 1s. 6d. per lb. It is the most abundant metal in the earth, and is manufactured all over the world.

About 23 years ago the author, as a boy, saw a lot of beautiful white-looking castings, made from pure aluminium, as the different alloys that are now known were then rare. Most metals will unite readily with aluminium, the exception being lead and antimony. Copper readily unites with it, imparting both strength and rigidity, but after a certain point it becomes too brittle to be of any use for making castings. Zinc to the extent of 25 per cent. is easily alloyed with aluminium, but with such a high zinc content as this it is unsuitable, except for the most common castings, on account of it being unstable and very liable to breakage under vibration. It also increases the specific gravity considerably.

Care has to be taken in a foundry where aluminium and brass are cast in the same shop, because if even a small piece the size of a shilling inadvertently gets into a pot of metal it makes the castings porous. On the other hand, when making very thin and fine work, such as nameplates, and the colour is not particular, a small piece, about an ounce, dropped into a pot of yellow brass just before pouring makes the metal very fluid, eliminates the obnoxious fumes normally thrown off by yellow brass, and gives the castings a clean skin with a bluish tint.

One difficulty met with was a certain design of radiator which did not contract equally, causing it to be porous and, therefore, leaky under pressure test. Some time elapsed before a suitable alloy was found for this, but eventually the difficulty was overcome by a high-copper alloy.

The next serious trouble came about during the war with the pistons for tank engines. Of the first eighty which were made, some were blown on the collar, some on the stem, and those free from these faults were pitted on the face or top of the piston. After this, three or four were machined as they were cast, various ways and means being tried to overcome these faults. The method of casting each piston was tabulated before being machined. This continued for some time, and became serious, as the castings were urgently wanted. The conclusion eventually arrived at was that the temperature was a great factor, as well as the method of moulding, so a pyrometer was installed, and after a few more experiments good castings were regularly produced. The casting temperature was 680 deg. C. After making nearly 4,000 pistons, die-casting was introduced to save machining, but a large percentage of wasters resulted, owing to their cracking on contracting, or after being run on test.

Table I. shows wasters resulting from the manufacture of pistons and crosshead guides made from December, 1916, to December, 1918 :—

Material.	Number despatched.	Percentage of wasters.
Pistons for 150 B.H.P. engine...	3,441	6.39
Crosshead guides for 160 B.H.P. engine	697	1.14
Pistons for 225 B.H.P. engine	265	nil
Crosshead guides for 225 B.H.P. engine	724	1.65
Gun metal crosshead guides for 150 B.H.P. engine	1,448	nil

To ascertain the temperature of liquid aluminium without a pyrometer is rather difficult, and depends to a great extent on the light conditions at the time of casting.

Another war casting, the camshaft housing for the Y 12 engines for submarine chasers, was about 66 in. long, 12 in. wide, and 3 in. deep. It resembled a piece of planking, but was cored out by about 15 cores. A great amount of trouble was at first experienced owing to cracking, drawing round the innumerable bosses, and the thick and thin parts of the casting. Eventually soundness was obtained by chilling the various parts, using altogether about 80 chills. If one of the chills was omitted it was sure to be drawn at that part. The casting only weighed 30 lb., and looked very frail considering its length.

Test-bars were required by the Admiralty for these, but the method of casting aluminium test-bars is not the same as that used for Admiralty gun-metal. They are not cast with the casting, but cast in a chill, the chill being split lengthwise so that it could be opened to allow of the bar being taken out easily and quickly. Before casting a bar the chill was plugged at the bottom with a little clay and warmed sufficiently to render it necessary to use tongs for handling. The chill was held at an angle of about 45 deg., and whilst pouring it was brought slowly to the perpendicular, thus avoiding any air locks. These bars had to stand 11 tons per sq. in. tensile and 4 per cent. elongation.

An aluminium casting that recently gave trouble was a disc about 2 ft. in diameter, with a thick boss in the centre. Six of these were cast in "L 5" alloy, but they all cracked in contraction. The alloy was then changed to 12 per cent. copper, and although they did not crack they buckled rather badly.

Cores for aluminium castings should be as loose as possible, to allow for quick contraction. Aluminium rapidly solidifies, and it is necessary to take a casting out of the mould as soon as possible, especially if there are cores in it, so that these can be dug out. Care must be taken not to put any undue strain on the casting, as aluminium is very hot-short.

A good flux for aluminium is salammoniac, which should be put on the metal and stirred, one or two minutes before taking from the fire, as the fumes it throws off are very unpleasant.

Another problem was the making of a large piston 12 in. in diameter and 30 in. long for Diesel engines weighing 140 lbs. This is rather a large mass of metal for an aluminium casting in the form of a piston, and before proceeding with the job the author was consulted as to how it (the pattern) should be made, whether it would cast on its side or on end. After going into the matter thoroughly it was decided to cast it on end, with

the head of the piston being the bottom of the mould. This departure from normal practice of making tank pistons on their side was decided upon so that the whole head of the piston could be chilled, as it was necessary that it should be absolutely solid. The head of the piston was concave, so the pattern was made with a print as though it was to be cored out, but instead of a core a convex chill was used, this being about 1½ in. thick at the thickest part, the skirt was chilled with four segments, these being 1 in. thick.

The chills in this case were made of iron, as it was thought that if they were made of aluminium the weight of metal poured on to them might cause them to partially melt, but in the future aluminium chills will be reverted to. When these pistons were machined they were found to be as solid as could be desired. With regard to the other chilled parts, such as round the gudgeon pin bearings, which were very thick, and round the gate, true sections were first got in plaster of Paris and then the aluminium chills made from those.

This piston was made in a four-part wooden box, the bottom part coming to the top of the skirt, the second part to the gudgeon pin holes, the third part to the top of the pattern and then the top part. Trouble was experienced in getting the air away from the top edges of the skirt and the top edge of the piston, as these were shut in by overhanging cores. The first one cast was full of little blow holes round these edges, so in the next one a little extra machining was put on the edges. The temperature of the metal was also a factor, for if it was too stiff it would not force the air out, and if it was too hot it would be porous on the body of the piston.

These were cast with two 300-lb. brass-capacity crucibles, and the method of casting was to have two very large heads with the gates covered by plungers, so that when the heads were filled the plungers were withdrawn and the mould was full without the heads going down, thus avoiding air getting into the mould and causing air-locks.

Five of these were cast, of which one was bad through the blow holes being too deep in the parts mentioned, due to a lower casting temperature than any of the others. Thus, stiffness of the metal had a great deal to do with it, and although it was not entirely obviated in the others, it was not of sufficient consequence to scrap the casting, as when they were machined there were very few of the blow holes that did not come out.

In one instance the gudgeon pin holes were fitted with P.B. bearings, but in the others the aluminium itself formed the bearings and gave more satisfaction. The wear on these was 1½ thousandths of an inch during 17 months, and running eight hours a day.

The peculiarities of aluminium, which is a treacherous metal to deal with, are manifold. Sometimes one fault is cured when another fault arises, and it is only by experience that one is able to deal with this metal with any degree of success.

There are occasions in brass founding when faults arise. For instance, for some years a certain casting has had to be made in hydraulic-metal to withstand 1,200 lb. pressure. Quite a lot of these were made without any cause for complaint before they began to leak under test. The method of moulding for the mixture had not been altered in any way whatever. After having several of these returned defective it was decided to change the place from where they had previously been gated, and this cured the defect. It is difficult to understand why these castings were defective, because at the same time castings to withstand 2,000 lb. pressure were being made without trouble. The fault may have been casting temperature.

One method of casting A.G.M. test-bars which gives satisfactory results, is to run the bar from the same gate that is used for gateing the casting, and not gated off the casting itself. The bar is also made a little longer than the required length and is connected with a riser, thus getting a complete flow of metal through the test-bar. Only two defective bars out of 124 tests have been returned by this method.

The bars usually stand from 15 to 18 tons per sq. in., as against 14 tons specified.

Discussion.

MR. MILES said aluminium could not be cleared without a flux of some kind. The best flux he had found for it was one-half common salt and one-half fluorspar. Some of the difficulties which have been experienced with a flange might have been avoided by altering the position of the ribs. He had found that three or five strengthening ribs instead of four would give a superior casting.

MR. SWIFT said the best method of getting good results with a high percentage of zinc in aluminium was to have the metal almost at freezing point before pouring in, as he considered that most difficulties were caused by running the metal too hot.

MR HOGG said there were certain castings, such as scraper mats, in which rubber was inserted. Some were made of an aluminium alloy, which must have been made very cheaply. The size was about 10 in. × 6 in. He could get them moulded at the rate of 60 a day, 12 in. × 8 in. box. Could Mr. Langton give any information about them?

He had used a mixture containing a small percentage of new aluminium with any scrap they could get hold of. The casting had to be buffed up by a wheel and emery cloth, and then done up with a brush, and they found that sometimes a slight tear was caused by the brush.

MR. CARTER agreed that sal-ammoniac was the best flux for aluminium. If no flux was used there would be a great percentage of loss. Had the lecturer any experience of what was termed ageing—that is, corrosion—taking place? He found that was one drawback to almost any alloy of aluminium if it was kept in a cold, damp place.

A MEMBER remarked that some aluminium taps which were cast years ago and had been kept in a storeroom did not show the slightest trace of corrosion; they turned as smoothly as ever. They were carried by travellers as samples of brass taps.

MR. KEY said at present he was using up a surplus of copper bands which had been accepted by the Admiralty. On analysis they were found to contain .03 of arsenic. They formed 5 per cent. of the mixture, so the arsenic content in the casting was .0015. They had not had test bars made to see how the material was affected so far as strength was concerned, and no bad effect had been observed.

MR. LANGTON, in reply, said 25 per cent. of zinc could only be used for a very common sort of casting. He agreed that it was not advisable to undertake casting in a brass foundry aluminium unless there were a large number to be made. He had not gone very closely into the matter of losses, but they were not 30 per cent. The addition of copper toughened it to a certain extent. If zinc was used in aluminium in quantity the casting would not stand the water pressure test.

FORTHCOMING EVENTS.

Birmingham.—"Jolt-Ram Machines," by G. A. Wardle (Wolverhampton) and "Pattern Plates for Floor and Machine Moulding," by C. Heggie (Birmingham), on April 2.

Coventry.—"Foundry Economics," by A. E. McIntosh, on April 6. Annual Meeting and Smoking Concert on April 8.

East Midlands.—Annual Meeting at Loughborough. Presidential address by H. H. Moore. Open Discussion: "Foundry Problems." Visit in the afternoon to Messrs. Taylor's, Bell Foundry, Loughborough, on April 2.

Lancashire.—"Safety in the Equipment of Foundries," by A. R. Bartlett (Belvedere, Kent), on April 2.

London.—"Pattern Plates for Floor and Machine," by C. Heggie (Oldbury), on April 14.

Newcastle.—Annual meeting, April 30.

Scottish.—Annual meeting. "More about Moulding Sands," by G. W. Tyrrell, on March 26.

Sheffield.—"Competition Against Castings and How to Meet It," by F. Rodgers, D.Eng., B.A., M.Sc., on April 15.

XUM

Trade Talk.

CLAYTON WAGONS, LIMITED, of Lincoln, are supplying 500 wagons to the South African Railways.

SEVERAL of the departments of the works of Wm. Beardmore & Company, Limited, have been closed down.

BELLIS & MORCOM, LIMITED, have removed their London offices from 8 to 25, Victoria Street, Westminster, S.W.

THE workers employed at the Haywood Forge, Hales Owen, have agreed to accept a reduction of 12½ per cent. in their wages.

ENGINEERS & IRONFOUNDERS, LIMITED, have acquired the whole of the issued share capital of Hunt Bros. (Oldbury), Limited.

AT a meeting of the River Tyne Commission it was reported that there were 115 vessels, totalling 135,788 tons, idle in the river.

VICKERS-PETERS, LIMITED, of Ipswich, are opening their new London offices and showrooms, at 75b, Queen Victoria Street, E.C.4, on March 29.

MELDRUMS, LIMITED, of Timperley, near Manchester, have appointed Mr. H. Astbury, Empire House, Birmingham, as their agent for Birmingham and district and the Black Country.

MANNESMANN TUBE WORKS, Swansea, which have been idle some weeks through depression in trade, were restarted last week. It is the company's intention to work every other week.

THE members of the South Wales Siemens Steel Association have applied to the men employed in the allied trades connected with the industry for a 50 per cent. reduction in wages.

THE PRINCE OF WALES is to be the guest of the evening at a London Chamber of Commerce dinner to be held at the Connaught Rooms on April 12. There is a great demand for tickets.

THE trade unions concerned in the Sheffield steel trade have received notice from the employers that a reduction of 17½ per cent. is proposed in the wages of men engaged in rolling mills and forges.

FIGURES compiled by the Department of Mines, Ottawa, estimate the total value of Canada's mineral production during the year 1920 at 40,000,000 sterling, as compared with £35,337,278 in 1919.

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LIMITED, Sheffield, have recently made extensive alterations and additions to their brick machinery department, and are now in a position to give delivery from stock.

A NEW oil-tanker, which is to have a carrying capacity of 8,000 tons, has been laid down at Devonport Dockyard on a slip adjoining that on which the tanker "Olna," 10,000 tons, laid down last June, is under construction.

A PAPER on "Locomotives" was read before the University Engineering Students' Association recently by Mr. R. H. Teather at the Engineers' Institute, Cardiff. Mr. David E. Roberts, M.Inst.C.E., was in the chair.

LAST week six mills were re-started at Messrs. Gilbertson's works at Pontardawe—three in the steel and three in the tin department—and employment will be provided for some 500 men. It is hoped more mills will re-start shortly.

A LECTURE on "Recent Researches in Photo-elasticity" was given at the Sheffield University on Monday to members of the Sheffield Society of Engineers and Metallurgists, by Professor E. G. Coker, of London University College.

ACCORDING to a report from the New York representative for the Leipsic Fair, the Copper Export Company in New York has made a contract with Germany for the delivery of copper to the value of $42,000,000 at 13 cents per English pound.

AT last Saturday's meeting of the Newcastle and District Branch of the Institution of British Foundrymen, held under the chairmanship of Mr. G. Vardy, Mr. J. E. Hurst, of Kirkcaldy, read an interesting paper on "Centrifugal Castings."

MR. EMERY, president of the Australian Mining Managers' Association, told the Select Committee inquiring into the decline of mining, that possibly a new process was coming along for cheapening smelting costs or even eliminating smelting.

DR. MACNAMARA, replying to Colonel Newman in the House of Commons, said it was estimated that 1,500,000 persons had their wages, or salaries, regulated according to the index figure of the cost of living prepared by the Ministry of Labour.

AT a general meeting of members of the North-east Coast Institution of Engineers and Shipbuilders at Newcastle, Mr. Wilfred Avre read a paper on "Organisation for Ship Production," dealing with the main hull structural portion of a ship.

THE members of the West of Scotland Iron and Steel Institute met in the Royal Technical College, Glasgow, last week, to hear a contribution by Messrs. W. H. Herdsman and S. C. Poole on "Developments of Iron and Steel Manufacture in South Africa and Australia."

THE secretary of the Health Week Committee, appointed by the Royal Sanitary Institute, announces that H.M. the King and H.M. the Queen have again graciously accorded their patronage to "Health Week," which will be held this year during the month of October.

THE FORTH SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, Alloa, have launched the cargo steamer "Hankefjell," which they have built for Messrs. Olsen & Ugelstad, of Christiania. The vessel is 285-ft. in length, 43-ft. 6-in. in breadth, 22-ft. 6-in. in depth, and of 4,150 tons deadweight.

DURING the last ten years the number of factories in South Australia increased by 7.04 per cent., the number using machinery by 21.58 per cent., the number of hands employed by 9 per cent. (males 7.18 per cent. and females 16.75 per cent.), while the employment of children under 16 years of age decreased 8.58 per cent.

AT a meeting of the Institution of Civil Engineers the following were transferred from the associate membership to membership:—Charles Alexander Falconer, district engineer's office, N.B. Railway, Carlisle; John Graham MacGregor, The Hawthorns, Carlisle; Richard Williamson, Oakhurst, Cockermouth.

SIR FREDERICK SYKES read a paper on "Civil Aviation" at a meeting of the Institute of Transport held at the Institution of Civil Engineers on March 14 stating, "To-day there is not a British air service in existence, though France is extending her air services and Germany has made a start notwithstanding the restrictions imposed by the peace treaty."

AT the resumed conference between the Engineering Employers' Federation and the Unions concerned in the engineering industry last week at York, wages questions affecting foundry workers in Kilmarnock and on the North-east coast, including Glasgow, were dealt with. Matters affecting metal trades in the Midlands area were also under consideration.

SIR ERNEST RUTHERFORD made a remarkable statement at the Royal Institution, lecturing on the subject of electricity. "The fundamental basis of electricity, which has puzzled the world since the time of Leyden, has been definitely established," he said. "Electricity is not fluid—it is not even 'juice'; it is atomic, and on that fact alone was it possible to raise the huge edifice of the universe."

A JOINT sub-committee of employers and employed in the hot dropped stamping trade in Birmingham and the Black Country met on the 14th inst., with a view to adopting a plan for tiding over the present difficulties. After a lengthy sitting, the sub-committee decided upon a joint recommendation to their respective bodies, which it is felt will overcome the difficulties, pending the outcome of the national negotiations now in progress.

THE guest of the Swansea Rotary Club on the 14th inst. was Mr. W. H. Evans, of the Department of Overseas Trade, who spoke on the mineral industries, in which Swansea is particularly interested. Dealing with the copper industry, he said that in the eighteenth century Swansea smelted about 75 per cent. of the world's production. It was a matter for regret, he said, that British interests were not more in evidence in the mining industries in Chili.

THE COSLETT ANTI-RUST SYNDICATE were claimants before the Inventions Commission in respect of the use of an anti-rust process. Mr. Moritz, for the Admiralty, said the claimants held patents for an ingenious method of rust prevention by which steel and iron had deposited on their surface a hard layer of phosphate of iron which was rust proof. The claim was for £300. The claim was allowed, Mr. Justice Sargant remarking that the sum asked seemed a moderate one.

THE text was issued on Saturday of a Bill presented by Lord Hylton to make provision for the cessation of the Ministry of Munitions and the Ministry of Shipping. The measure provides that an Order in Council fixing a date earlier than the termination of twelve months after the conclusion of the war as the date on which the offices mentioned are to cease, may transfer to any Government Department any property, rights, and liabilities attaching to the Ministries, provide for the discontinuance of any of the powers of the Ministers, and for the transfer to some other Government Department of such powers as are not discontinued.

THERMIT, LIMITED, a constituent company of Nobel Industries, Limited, have made arrangements to transfer their extensive works at 675, Commercial Road, E.14, to 155, Church Road, Battersea, S.W.11, to date from 25th inst. Thermit, Limited, are producers of carbon-free pure metals and alloys, and also proprietors of a very effective method of Thermit welding. Their latest development is a system of welding rail-ends of existing tram tracks where the joints are badly dished, a process which is not only a permanent repair, but also only needs a minimum disturbance of the road when the track is being repaired.

Personal.

THE late Mr. James Heyworth Vickery, of Southdowns Cottage, Southdowns Road, Bowden, Cheshire, metal merchant, governing director of James H. Vickery & Company, Limited, Manchester, left £10,565.

MR. A. C. ROSS, managing director of Messrs. Hawthorn, Leslie & Company, Limited, St. Peters, has presented to the Amalgamated Engineering Union's Institute, Newcastle, through Mr. Charles Procter (secretary), a number of framed sketches of the various classes of turbine and other machinery for which the St. Peters' works are justly famous.

DR. F. C. THOMPSON, at present Sorby Research Fellow in the University, has just been appointed Professor of Metallurgy in the University of Manchester. Dr. Thompson received his training entirely in Sheffield, and is the author of about twenty scientific papers on metallurgical subjects dealing chiefly with surface tension effects in metals and with the properties of nickel silver. He was appointed Carnegie Scholar of the Iron and Steel Institute in 1920.

Company News.

Marbella Iron Ore, Limited.—Dividend of 6s. per share, less tax.

Coltness Iron, Limited.—Interim dividend on ordinary of 3 per cent. actual for year to July last.

Palmer's Shipbuilding & Iron Company, Limited. — Interim dividend of 2½ per cent. on the ordinary shares.

Ibbotson Brothers & Company, Limited.—An interim dividend at rate of 5 per cent. per annum, tax free, payable March 31.

Howard & Bullough, Limited.—Interim dividend of 10 per cent. per annum (6d. per share), less income tax, on ordinary for quarter.

H. and C. Grayson, Limited, have declared interim dividend on deferred shares of 2½ per cent., less tax, payable April 15, to holders registered April 1.

Humber Graving Dock & Engineering, Limited. — Interim dividend at rate of 4 per cent. per annum, less tax, on ordinary on account of year ending June 30, 1921.

Scottish Tube Company, Limited. — The Scottish Tube Company recommend a dividend on the ordinary shares of 5 per cent., and a bonus of 5 per cent. for the past year.

British Metal Corporation, Limited.—Profit for 1920, £37,349; plus £6,265 brought in, making £43,614. Dividend of 6 per cent. for year; £2,000 to staff superannuation fund; £6,774 forward.

Steel Developments, Limited.—Profit for 1920, £4,766, and £1,559 was brought in, making £6,325. Dividend for year of 5 per cent., free of tax; to depreciation of investments, £1,600; forward, £1,281.

Hadfields, Limited.—Directors recommend, in addition to interim of 6d. per share paid in July on ordinary, further dividend on ordinary of 6d. per share, making total dividend of 5 per cent., free of tax, for the year.

Muntz's Metal, Limited.—Final dividend at rate of 5 per cent. per annum on preference, and 15 per cent. per annum on ordinary, less income tax in each case, for period of five months from August 1, 1920, to December 31, 1920.

The Scottish Iron & Steel Company, Limited. — Recommend dividend on preference shares at rate of 4 per cent. actual, making 8 per cent., and dividend on ordinary shares at rate of 5 per cent. actual, making 10 per cent., both payable, less tax.

Engineers & Ironfounders Company, Limited.—Net profits for the past year were £5,475. A final dividend of 2s. per share is proposed on the ordinary shares, making 4s. per share for the twelve months, and carrying forward £999, subject to directors' fees.

Cope, Allman & Company, Limited.—Accounts for year ended December last show profit of £17,248. Adding balance brought forward, £5,000, amount available is £22,270. Dividend at rate of 20 per cent. on ordinary, the same; to general reserve, £7,000; forward, £10,685.

Lincoln Wagon & Engine, Limited.—Balance of profit, including the sum brought in, is £38,759. The directors recommend a further dividend of 5 per cent., making 10 per cent. for the year, less tax, and a bonus of 1s. 6d. per share, free of tax; to reserve, £10,000; forward, £14,509.

North British Locomotive, Limited.—Profit for 1920, £233,220; balance brought forward, £338,783; available balance, £572,003; dividend on preference of 5 per cent., less tax, for year; dividend on ordinary of 10 per cent., free of tax, for year; transfer to special fund for benefit of employés, £5,000; £404,503 carried forward.

David Matthews, Limited.—Capital, £25,000 in £1 shares. To carry on the business of metal merchants and brokers, dealers in iron, steel, and tin-plates, etc., and to adopt an agreement with D. Matthews. The first directors are:—D. Matthews (permanent), and W. Harries. Registered office: 108, Woodfield Street, Morrison, Swansea.

Rivet, Bolt, & Nut, Limited.— Profits for 1920, £121,744, less dividend of 5 per cent. per annum on preference for year, leaving £107,994. Directors propose to transfer to ordinary reserve fund, £42,500; to employés' benefit reserve, £2,000; dividend at rate of 6 per cent. (less tax) on ordinary for year, and bonus of 6 per cent. (less tax) on ordinary, carrying forward £13,994.

Stewarts & Lloyds, Limited.—Dividend on fully-paid deferred shares, 2s., and bonus, 1s.; on 10s. paid shares, 6d., and bonus, 3d.; and on fully-paid shares issued in July last in exchange for Alfred Hickman shares, 1s., and bonus, 6d.; £70,000 is set aside for depreciation; £150,000 placed to reserve; £10,000 to employés benefit reserve; and £110,000 carried forward.

Gazette.

EASTON ENGINEERING AND CONSTRUCTION COMPANY, LIMITED, London, W.C.—Winding-up order March 8.

TORBINIA ENGINEERING COMPANY, LIMITED, Norwich. —Mr. G. H. Bullimore, Old Bank of England Court, Queen Street, Norwich, appointed receiver March 1.

FRENCH AUTOGENE WELDING COMPANY, LIMITED. — Resolved February 14, confirmed March 1: That the company be wound up voluntarily. Mr. S. M. Laird, 3, Laurence Pountney Hill, E.C., liquidator.

MURRAY FOUNDRY COMPANY, LIMITED.—Resolved February 2, confirmed February 23: That the company be wound up voluntarily. Mr. D. F. Middlemiss, 6 and 7, Coleman Street, E.C., C.A., appointed liquidator.

DEPTFORD STEEL AND IRONWORKS, LIMITED.—Resolved February 15, confirmed March 3: That the company be wound up voluntarily. Mr. S. H. Baker, Eldon Street House, Eldon Street, E.C., F.C.A., liquidator. Claims to liquidator by May 2.

STEEL TRADING CORPORATION, LIMITED.—Resolved February 14, confirmed March 1: That the company be wound up voluntarily. Mr. R. Kettle, partner of Deloitte, Plender, Griffiths & Company, appointed liquidator.

VECTIS ENGINEERING COMPANY, LIMITED, London, S.W.—Resolved March 31, 1920, confirmed April 15, 1920: That the company be wound up voluntarily. Winifred M. Fay, 38, Victoria Street, Westminster, secretary to a limited company, liquidator.

The winter session of the Leicester Association of Engineers terminated on Friday last, when the annual meeting was held in St. Martin's Church House, the president, Mr. P. A. Bentley, being in the chair. After the alteration of several of the rules, the following election of officers for the coming year took place: President, Mr. P. A. Bentley, A.M.I.M.E., vice-presidents, Messrs. L. Rowland, B.Sc., A.M.I.C.E.; R. W. Taylor, P.I.C.P.A.; Thos. Wood and R. B. Woodcock; joint hon. secretaries, Messrs. F. C. Pulsford, A.M.I.M.E., and B. P. Cooper. Several hon. vice-presidents, who are to take the chair at the association's meetings, were elected, viz.: Messrs. C. Parson, J.P., W. Freer, J. M. Gimson, Russell Gimson, D. N. Nesbitt, J. H. Parsons, J. Pegg, S. W. Wilkinson, S. Russell, W. Taylor, and C. Stibbe. Of the three students who had submitted papers, Messrs. Thorne and Gamble gained first place equally, and Mr. Kestell was awarded a consolation prize.

A general discussion on "Failure of Metals" will be held on Wednesday, April 6, 1921, under the conjoint auspices of the Iron and Steel Institute, the Institution of Mechanical Engineers, the Faraday Society and the Institute of Metals, at the Institution of Mechanical Engineers, Storeys Gate, Westminster. There will be three sessions, commencing at 3.0 p.m., 5.0 p.m., and 8.0 p.m. respectively, with intervals for tea and dinner. Arrangements are being made to enable those attending to dine together at 6.45 p.m., at the Victoria Mansions Restaurant, 24, Victoria Street. Professor Alfred W. Porter, D.Sc., F.R.S., President of the Faraday Society, will preside at the first session, when an introductory address will be delivered by Dr. W. Rosenhain, F.R.S., after which the chair will be taken by Captain H. Riall Sankey, C.B., president of the Institution of Mechanical Engineers. Dr. J. E. Stead, F.R.S., president of the Iron and Steel Institute, will preside at the second session, and Eng. Vice-Admiral Sir George Goodwin, president of the Institute of Metals, will preside at the third session. At each of these sessions a selection of papers will be submitted.

XUM

IRON AND STEEL MARKETS.

Pig-Iron.

The imminence of the Easter holidays concurrent with the close of the first quarter of the year are contributory factors in intensifying the general depression which has prevailed of late in the pig-iron industry without, so far, any apparent prospect of improvement in the near future. The position at present is convincingly explained in a return of pig-iron production in February submitted by the National Federation of Iron and Steel Manufacturers, showing a total of 463,500 tons, a figure, if we except the months affected by the railway strike in 1919 and the coal strike in 1920, lower than in any month since monthly figures have been recorded. Of the total production 171,800 tons were hematite pig-iron, 97,800 tons basic iron, 127,000 tons foundry, 41,200 forge, 9,300 tons ferro-alloys, and 16,500 tons "other qualities." Even the drastic reductions in current prices, effected recently, have apparently been ineffectual in stemming the tide of foreign invasion of British markets, and although makers are now offering pig-iron at pounds below the cost of production, they cannot find sufficient buyers to keep furnaces employed, and every week witnesses an addition to idle plants. Such a state of things cannot, however, last long. Cheap lots of Lincolnshire iron continue to be offered at Sheffield. This material comes out of stocks, as there is little or no production in that district. At Cleveland it is now generally admitted that prices are still too high to cope with outside competition abroad, but makers are disinclined for further movement in that direction until a satisfactory settlement of the fuels supplies question has been determined. It is, however, understood that the Durham coke makers are meeting in Newcastle this week, and if the outcome of their deliberations fulfils expectations there should be an immediate reduction in coke prices which will bring appreciable relief to the ironmasters. As at present Durham blast-furnace coke is 54s. 6d. per ton at the ovens, compared with a corresponding quotation of 45s. per ton in the Midlands, there seems room for some relief to the local producers of pig-iron. It may be regarded as doubtful whether an immediate decrease in fuel costs would eventuate in a further drop in pig-iron quotations, and it is doubtful whether any change of importance will be made until the end of the current month. Prices accordingly are as follow:—For home consumption, with 5s. per ton more in all cases for export: No. 1 and silicious, 155s. per ton; No. 3 Cleveland G.M.B., 150s.; No. 4 foundry, 149s.; No. 4 forge and mottled, 147s. 6d.; white, 145s. per ton. In the Lancashire foundry iron market there is no indication of increased interest on the part of consumers, but as they have been out of the market for some months they cannot now have any very large stocks in hand. It is, however, probable that the demand for new castings is not what it was, and the prospect of lessening work makes all foundrymen chary about buying iron. The ideas of price are about what they were last week, but at present the Midland makers have not all come down to prices which are competitive with Cleveland.

The continued stagnation in the steel trade has had a corresponding effect upon the hematite iron industry, and production is now reduced to minimum proportions. Only small odd lots of East Coast hematite are reported changing hands. For home use, as well as for shipment abroad, Nos. 1, 2, and 3 are quoted 180s., and No. 1 182s. 6d. In West Cumberland the recent reduction in hematite prices has done little to stimulate buying, but a certain tonnage is going into consumption, as evidenced by the resumption of operations at two of the furnaces at Millom and at one of the furnaces at Cleator Moor, the total now blowing between Workington and Carnforth being fourteen. But iron, it is believed, will have to fall perhaps another £1 per ton before there is any buying on a larger scale. A further drop in values, however, is impossible until the situation in the coal industry is resolved. Meanwhile, the price for hematite mixed numbers remains at £9 per ton.

Ore.

The Tees-side market for foreign ore is absolutely lifeless, smelters, as a result of the recent restriction of outputs of pig-iron, having in the majority of cases large stocks on hand, and are consequently abstaining from further commitments. Nominally 37s. 6d. per ton c.i.f. is the figure for best rubio ore, but there has been no business, and it is little guide to the real state of the market. In West Cumberland a good deal of the ore consumed by the furnaces on ordinary iron is Spanish, and the demand for native metal is, therefore, limited. Several mines, however, are raising superior sorts of ore for the furnaces on low phosphorus iron.

Scrap.

The position in the scrap market at present is an exact reflex of the industrial situation, consumption being practically at a standstill and prices purely nominal. Foundries especially are now sharing in the depression experienced in all branches of the iron and steel trade, and are off the market for good machinery scrap. In South Wales, an extremely active market in normal times, trade in scrap is stagnant, the following quotations representing mostly dealers' ideas of values:—Heavy steel scrap, £3 10s. to £4 10s. and less; bundled steel scrap and shearings, £3 to £4 10s.; mixed wrought-iron and steel scrap for basic furnaces, 30s. to £4 10s., according to quality; heavy cast-iron scrap in furnace sizes, £5 to £6; and good machinery scrap, £7 to £8.

Steel.

Conditions in the steel trade could hardly be less promising than at present, and there can be no question that a critical stage in the position of the industry has been developed, threatening a cessation of activity in many of the more important manufacturing departments, with incalculable loss alike to employers and employed. The recent price-cutting tactics adopted by Sheffield makers to meet the emergency have so far failed to encourage buying on a more liberal scale, and only a minimum of new business is reported, the few branches now provided with work being confined to the lighter Sheffield products in the form of files, engineers' hand tools, saws, and other implements of trade, for which considerable orders are in hand. In the semi-products market, Bessemer acid billets have been reduced. The Bright Steel Makers' Association have reduced the price of bars to £25, a drop of £7. Rolling mills are working half-time, and forges have very little to do. The demand for railway material is fairly maintained, the axle, spring, and tyre branches having a moderate tonnage on order, but contracts, both for home and abroad, have been, so far, disappointing this year. In North Lancashire the steel trade is only fairly employed, some of the departments at Barrow having been stopped part of the time, but the Siemens branches, the rolling mills, and the foundries are now at work. The demand for all descriptions of steel is poor, and the outlook is disquieting. Last week two shipments of steel rails were made from Barrow to Kingstown. Finished steel products have been reduced this week.

Finished Iron.

There is very little encouraging to report in the conditions of the finished iron trade, with perhaps a solitary exception as furnished in the prospect of some lightening of the heavy load of wages cost anticipated in next month's ascertainment of the Wages Board. The relief obtained in this direction will be welcomed by manufacturers, but will be altogether inadequate to counter-balance other heavy items of expenditure, and consequently can have only a limited effect in reducing quotations of finished materials to anything like a competitive basis with our foreign imports. Meantime prospective buyers of finished materials in the home markets are mostly postponing negotiations till the quarterly meeting, the majority of manufacturers ceasing operations next week, in view of the holidays, which, it is expected, will be extended beyond the usual limits on this occasion. There have been several reductions recently in the prices of various iron and steel prices in Denmark. After cutting the price of iron girders, that of iron rods, plates, etc., fell 20 or 30 per cent. The imports of iron, steel, etc., at Hull from abroad in the past week include:—Iron: pig, 682 tons (Bleasdale & Company), 50 tons (Wilson's and North-Eastern Railway Company), 15 tons (Furley & Company); bar, 49 tons (Wilson's and North-Eastern Railway Company), 14 tons (Furley & Company); scrap, 8½ tons (Bleasdale & Company). Steel: 207 tons (Furley & Company), 106 tons (Wilson's and North-Eastern Railway Company), 71 tons (Ellerman's Wilson Line), 20 tons (Ohlson & Company), 48 tons (Bleasdale & Company). Grimsby.—Iron: 38 bundles bars; steel, 32 tons rails, 525 billets, 64 joists, 1,147 castings, 332 bars, 367 bundles plates. Goole.—Iron: 4 tons pig, 24,659 bars, 3,697 bundles ditto, 937 plates. Steel: 1,426 billets, 1,145 rails, 10 girders, 852 sheets (order).

SIEMENS' STEEL PROCESS

BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS. RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

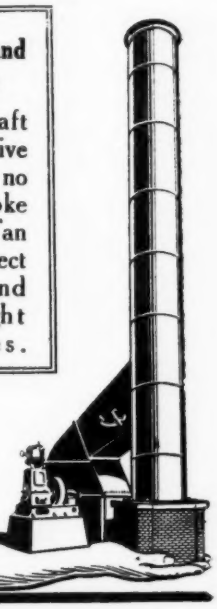
Established 1872. *Telegraphic Address: "Steel, Glasgow."*

"Coal Economy is in the Air"

On the one hand
Natural Draught with costly brick chimney emitting black smoke that spells waste and the draught at the mercy of the atmospheric conditions.

Send for Catalogue No. 1009.

On the other hand
SIROCCO
Induced Draft with inexpensive steel stack and no wasteful smoke because the Fan ensures perfect combustion and correct draught at all times.



DAVIDSON & Co LTD.
SIROCCO WORKS,
BELFAST.
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GEORGE JONES, Limited,

ESTABLISHED, 1803.

LIONEL STREET FOUNDRY, BIRMINGHAM.

Complete Rolling Mills for all Metals.

Machinery for Making Tubes and Wire.

MILL GEARING OF EVERY DESCRIPTION.

Refractories.

Orders for refractory materials this week have been more plentiful than for some time. The demand for ganister for ironfoundries has improved, and is steadily maintained. The demand for steel moulding sands fluctuates considerably, and this last week a good many firms have suspended deliveries. There are, however, indications that in the early future this branch of the trade will improve considerably. The demand for silica bricks is very low, but for magnesite bricks is maintained. The tendency of the quotations for silicas is much easier, as manufacturers are holding large stocks. The current prices for the principal refractory materials are as per the list published in our last issue.

Tinplates.

Though still experiencing very quiet conditions, inquiries for tinplates are coming forward a little better from abroad, but tangible orders are not being placed. It is some satisfaction to learn that American business is in a similar plight, the reason being that foreign buyers are holding their hands, except for most pressing immediate requirements, and awaiting a further drop in prices. This, it should be understood, can only be effected by a reduction of production costs; at the present moment tinplates are changing hands at 6s. a box below the actual cost of production. The business done has been almost entirely confined to stock plates, which have been changing hands in the neighbourhood of 25s. to 26s. per basis box for coke finish, net cash, f.o.t. at works. For plates to make, however, 28s. 6d. to 29s. is generally quoted, a small trade only being reported on this basis. In regard to wasters, these are being bought by consumers, tempted by the very low prices now ruling. C.W. 14 by 18¾ have been sold as low as 12s. 6d., but are now firmer at 14s. C.W. 28 by 20 are realising round 39s. a box. Terneplates are exceedingly quiet; 27s. 6d. is generally quoted for usual finish, net, f.o.t. at works.

Metals.

Copper.—With a fairly active demand on consumer's account, the week's copper markets opened quiet but steady, but buying was mostly restricted to some forward business. Sales for April were marked at £67 15s. to £68, May and June at £67, and three months at £66 15s. to £66 10s. up to £67. Electrolytic and wire bars were both unchanged at £70 10s. to £71 10s. Stocks of copper in Havre on March 15 amounted to 7,254 tons, as compared with 5,778 tons on February 28. Closing prices:—Cash: Wednesday, £67; Thursday, £67; Friday, £68; Monday, £67 15s.; Tuesday, £68. Three Months: Wednesday, £66 10s.; Thursday, £66 10s.; Friday, £66 15s.; Monday, £66 15s.; Tuesday, £66 15s.

Tin.—Eastern advices reporting sales of Straits tin at £160 10s. c.i.f., an advance of 30s., stimulated the opening market of the week, and prices here responded with an improvement of 20s. Sellers, however, maintained their attitude of reserve, and prices further stiffened, closing firm with cash 27s. 6d. and three months' 37s. 6d. higher. Sales recorded included April, £157 to £158; May, £157 to £158 10s.; June, £158 10s. to £159 10s., three months, £159 to £159 10s. English ingots were also 20s. higher at £152 to £153. The weekly return of stocks in London is 86 tons decrease at 4,677 tons; Liverpool, 53 tons to 2,143 tons; and Swansea unchanged at 142 tons. Closing prices:—Cash: Wednesday, £153; Thursday, £156; Friday, £154 15s.; Monday, £156; Tuesday, £157. Three Months: Wednesday, £156; Thursday, £159 to £159 10s.; Friday, £157 15s.; Monday, £159 10s.; Tuesday, £160 10s.

Spelter.—Business in this metal has been inactive, but the tone continues steady, with forward dates showing a slightly upward tendency. Statistics published by Messrs. Rudolf Wolff & Company show that the world's total production of spelter during 1920 was 698,875 tons, being 63,379 tons more than in the previous year, but 284,665 tons below the output for 1913. Ordinary brands prompt were quoted £18 17s. 6d., English steady at £20.

Lead.—Transactions in this metal have been on a much curtailed scale, the only business reported in Monday's market being a carry over from April to July at 7s. 6d. contango. Soft foreign prompt closed £18 17s. 6d., English steady at £20.

£100,000

will purchase

LARGE IRON AND STEEL WORKS

in the liberated area of

NORTHERN FRANCE.

Area of site 200,000 sq. metres, of which 10,000 sq. metres are enclosed. Unique situation as regards Railway and Canal. Modern Machine Tools and equipment. Works ready to produce 8,000 tons annually. Bridges and other Structural Work, Wire Works, Machinery. Apply to—

M. Le GENTIL,

Avoué, at Arras (France).

There's something for You among these —

Blacking, Coal Dust, Plumbago, Charcoal, Core Gum, Terra Flake, Gannister, Core Oils, Sea Sand, Moulding Sand, Iron Cement, Brushes, Bellows, Buckets, Chaplets, Core Ropes, Core Tapers, Ladles, Crucibles, Cupolas, Riddles, Sprigs, Spades, Carborundum Bricks and Wheels, Ferro-Aluminium, Blacking Bags, Foundry Plant, Etc., Etc., Etc.

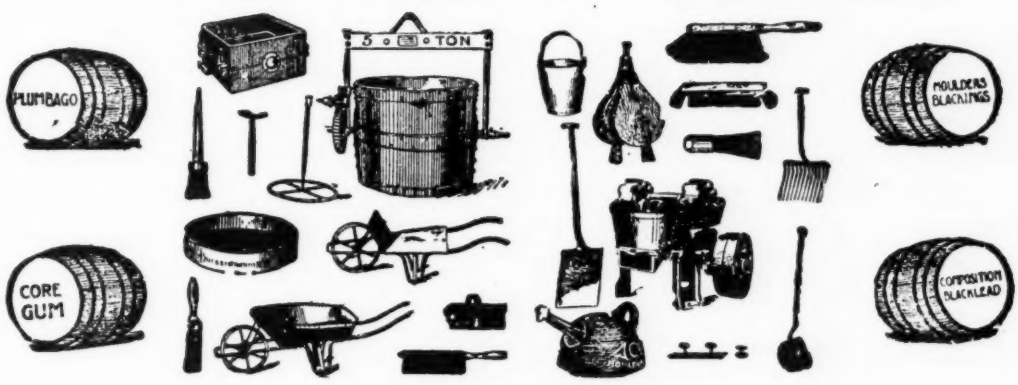
F. L. HUNT & CO., 56, 58, 60, Chapel Street, Salford, Manchester.

Telephone: 21, Penistone. Telegrams: "Durrano, Penistone."

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



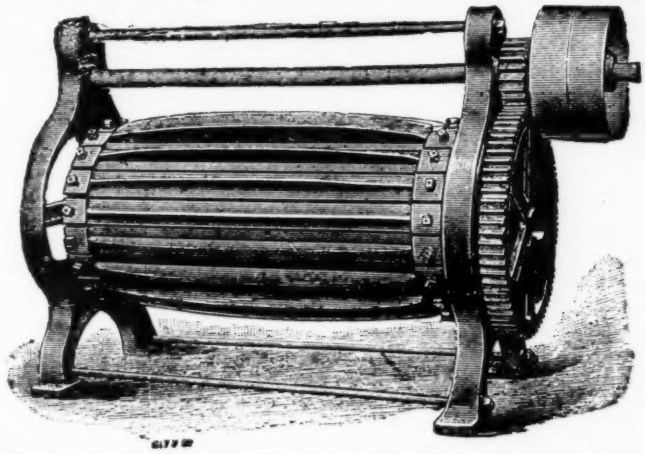
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully. THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	68	0	0
Three months	65	15	0
Electrolytic	70	10	0
Tough	68	0	0
Best selected	68	10	0
Sheets	114	0	0
India	114	0	0
Wire bars	71	0	0
Do. April	71	0	0
Do. May	71	0	0
Ingot bars	70	10	0
H.C. wire rods	79	0	0
Off. aver. cash, Feb.	71	0	9
Do. 3 mths., Feb.	70	14	10½
Do. Settlement Feb.	71	0	4½
Do. Electro. Feb.	76	15	6
Do. B.S., Feb.	75	1	10½
Aver. spot, copper, Feb.	71	0	0
Do. Electro, Feb.	77	12	6

Solid drawn tubes .. 15½d.
Brazed tubes .. .. 15½d.
Wire .. .. .. 12d.
Yellow metal rods .. 9d.
Do. 4x4 Squares .. 11d.
Do. 4x3 Sheets .. 11d.

BRASS.

Solid drawn tubes .. 13¾ l.
Brazed tubes .. .. 16¾ l
Rods .. .. .. 12¾ l.
Sheets to 10 w.g. .. 12¼ l.
Wire .. .. .. 12¾ l.
Rolled metal .. 11¾d.

TIN.

Standard cash	157	0	0
Three Months	160	10	0
English	153	0	0
Bars	155	0	0
Chinese	149	0	0
Straits	163	0	0
Australian	162	0	0
Eastern	163	0	0
Banca	170	0	0
Off. aver., cash, Feb.	166	9	1½
Do. 3 mths., Feb	170	16	3
Do. Sttlment., Feb.	166	6	6
Aver. spot, Feb.	166	5	3

SPELTER.

	£	s.	d.
Ordinary	25	0	0
Remelted	21	15	0
Hard	19	10	0
Electro 99.9	33	5	0
English	28	0	0
India	22	10	0
Prime Western	25	15	0
Zinc dust	57	10	0
Zinc ashes	6	5	0
Off. aver., Feb.	25	5	5¼
Aver., spot, Feb.	22	17	0

LEAD.

	£	s.	d.
Soft foreign ppt	18	17	6
English	20	0	0
Off. average, Feb.	21	0	0
Average spot, Feb.	20	13	7½

ZINC SHEETS.

Zinc sheets, spot	36	0	0
Do. V.M. ex. whf	37	0	0
Do. ppt., f.o.b., N.Y.			—
Dutch	36	0	0
Boiler plates	34	0	0
Battery plates	33	10	0

ANTIMONY.

English regulus	37	5	0
Special brands	42	0	0
Chinese	23	10	0
Crude	19	5	0

QUICKSILVER.

Quicksilver 12 10 0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—
45/50% 18 0 0
75% 26 10 0
Ferro-vanadium—
35/40% .. 25/- lb. va.
Ferro-molybdenum—
70/80% .. 8/- lb. mo.
Ferro-titanium—
23/25%, carbonless 1/6 lb.
Ferro-phosphorus, 20/23%, £34
Ferro-tungsten—
80/85%, carbon free 1/10 lb.
Tungsten metal powder—
98/99% .. .. 3/- lb.
Ferro-chrome—
4/6% car. £37 10
6/8% car. £37
8/10% car. .. £36 10
Ferro-chrome—
Max. 2% car. .. £84
Max. 1% car. .. £100
Max. 0.75% car. .. £116
65/75%, carbonless 3/- lb.
Nickel—99·8%, cubes or pellets .. £200
Cobalt metal—97%.. 20/- lb.
Aluminium—98/99% £150
Metallic Chromium—
98/99% .. .. 6/6 lb.
Ferro-manganese—
76/80%, loose .. £25
76/80%, packed .. £26
76/80%, export .. £22 10
Metallic manganese—
98/99%, carbonless 3/1 lb.
Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten .. .. s. d. 3 2
Finished bars, 18% tungsten 4 0
Scrap pieces .. .. 5d.
Turnings and swarf .. 3d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares 3 in. to 8 in. inclusive 4d. lb.
Rounds and squares under ½ in. to ¼ in. 3d. lb.
Flats under 1 in. by ⅜ in. to ½ in. by ¼ in., and all sizes over four times in width over thickness .. .. 3d. lb.
Bevels of approved sizes and sections .. 6d. lb.
If in coils .. .. 3d. lb.
Packing .. ..4s. cwt
Bars cut to length 10% extra
Scrap from high-speed tool steel—
Scrap pieces .. .. 5d.
Turnings and swarf .. 3d.
Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—£ s. d.			
Heavy Steel	4	0	0
Bundled steel & shearings	4	0	0
Mixed iron & steel .. 2 0 0	5	0	0
Heavy cast iron ..	5	10	0
Good machinery for foundries ..	7	10	0
Cleveland—			
Heavy steel ..	3	5	0
Steel turnings ..	2	10	0
Cast-iron borings	2	10	0
Heavy wrought iron piling	5	15	0
Bundling scrap ..	5	5	0
Cast-iron scrap ..	7	0	0
Lancashire—			
Cast iron scrap ..	7	10	0
Heavy wrought ..	4	10	0
Steel turnings ..	2	10	0
London—			
Copper (clean) ..	53	0	0
Brass (clean) ..	30	0	0
Lead (less usual draft) ..	14	0	0
Tea lead	12	0	0
Zinc	12	0	0
New aluminium cuttings ..	70	0	0
Braziery copper ..	43	0	0
Gun metal ..	50	0	0
Hollow pewter ..	110	0	0
Shaped black pewter	65	0	0

PIG-IRON.

N.-E. Coast—
Foundry No. 1 .. 155/-
Foundry No. 3 .. 150/-
Forge No. 4 .. .. 149/-
Mottled 147/6
Hematite No. 1 .. 182/6
Hematite M/Nos. .. 180/-

Midlands—
Staffs. common .. 145/-
„ part-mine forge 160/-
„ „ foundry 170/-
„ Cold blast .. 360/-
„ basic 135/-
Northants forge .. 140/-
„ foundry No. 3 160/-
„ basic 140/-
Derbyshire forge .. 160/-
„ foundry No. 3 165/-
„ basic .. 160/-

Scotland—
Foundry No. 1 .. 175/-
„ No. 3 .. 170/-
Hematite M/Nos. .. 185/-

Sheffield (d/d district)—
Derby forge 165/-
„ foundry No. 3 170/-
„ basic 165/-
Lincs. forge 180/-
„ foundry No. 3 185/-
„ basic 152/6
E.C. hematite .. 193/-
W.C. hematite .. 196/-
All d/d in the district.

Lancashire (d/d eq. Man.)—
Derby forge .. .. —
„ foundry No. 3 180/-
Northants foundry No. 3 .. .. —
Cleveland foundry No. 3 .. .. —
Staffs. foundry No. 3 —
Lincs. forge 192/6
„ foundry No. 3 197/6
Summerlee foundry .. 215/6
Glengarnock foundry 215/6
Gartsherrie foundry 215/6
Monkland foundry .. 215/6

FINISHED IRON & STEEL.

Iron—	£	s.	£	s.	d.
Bars (cro'n)	20	0	24	10	0
Angles ..	20	10	25	0	0
Tees to 3 united ins. ..	21	0	25	10	0
Nut and bolt ..			22	0	0
Hoops			23	0	0
Marked bars (Staffs.) ..			27	10	0
Gas strip ..			26	0	0
Bolts and nuts, ¾ in. × 4 in.			42	0	0
Steel—					
Ship plates ..			19	0	0
Boiler plates ..			25	0	0
Checquer plates			22	0	0
Angles			17	10	0
Tees			18	10	0
Channels ..			18	0	0
Joists			17	10	0
Rounds, ⅜ in.–3-in.			18	0	0
Rounds, 3 in.–5½ in. ..			17	0	0
Flats, 5 in.–8 in.			17	10	0
Flats over 8 in.			17	0	0
Rails, heavy ..			18	0	0
Fishplates ..			23	0	0
Hoops			18	10	0
Black sheets, 24 g.			23	0	0
Galv. cor. sheets, 24 g.			24	0	0
Galv. fencing wire, 8 g. plain ..			30	0	0
Rivets, ¾ in. dia			30	0	0
Billets, soft ..			13	10	0
Billets, hard ..			14	10	0
Sheet and tin bars			14	10	0

PHOSPHOR BRONZE.

Rolled.	Per lb. s.	d.
½ in. to 1 in. wide ..	1	11½
1 in. to 1½ in. wide ..	1	10½
1½ in. to 2 in. wide ..	1	9½

Strips.	s.	d
2 in. to 6 in. to 26 S.W.G.	1	8½
6 in. to 12 in. to 26 S.W.G.	1	8½

Sheets.	s.	d.
12 in. to 18 in. to 24 S.W.G.	1	9
18 in. to 24 in. to 24 S.W.G.	1	9½
24 in. to 30 in. to 20 S.W.G.	1	10½
30 in. to 36 in. to 16 S.W.G.	1	11½
36 in. to 42 in. to 16 S.W.G.	2	0½

Extras.
For Gauge: Any width up to 36 in. wide, ½d. per lb. per thinner gauge.

Drawn Rods.	s.	d.
¼ in. to ⅞ in. dia. in random lengths / ⅞ in. to 1½ in. dia. in random lengths	1	9½
Over 1½ in. to 1⅝ in. ..	1	9½
Tubes—basis price ..	1	11½

Delivery 2 cwt. free to any town.
10% phosphor copper, £40 above price of B.S.
15% phosphor copper, £50 above price of B.S.
Phosphor tin (5%), £30 above price of English ingots.
Charles Clifford & Son, Limited, Birmingham.

NICKEL SILVER, SHEET METAL, WIRE AND TUBES.

	Per lb.
Ingots for raising	1/3 to 1/9
Rolled—	
To 9 in. wide	1/10½ to 2/4½
To 12 in. wide	1/11 to 2/5
To 15 in. wide	2/- to 2/6
To 18 in. wide	2/1 to 2/7
To 21 in. wide	2/2 to 2/8
To 24 in. wide	2/3 to 2/9
Ingots for spoons and forks ..	1/3 to 1/9
Ingots rolled to spoon size ..	1/6 to 2/-
Wire round—	
3/0 to 10. G. ..	2/1 to 2/8

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	27.84
No. 2 foundry Valley	26.00
No. 2 foundry, Birm.	25.00
Basic	27.26
Bessemer	28.96
Malleable	26.00
Grey forge	26.96
Ferro-manganese 80 % delievred	90.00
Bess. rails, h'y, at mill	45.00
O.-h. rails, h'y, at mill	47.00
Bess. billets	38.50
O.-h. billets	38.50
O.-h. sheet bars ..	40.00
Wire rods	52.00
	Cents.
Iron bars, Phila. ..	2.50
Steel bars	2.00
Tank plates	2.10
Beams, etc.	2.10
Skelp, grooved steel ..	2.35
Skelp, sheared steel ..	2.25
Steel hoops	2.80
Sheets, black, No. 28 ..	3.85
Sheets, galv., No. 28 ..	5.00
Sheets, blue an'l'd, 9&10	3.00
Wire nails	3.00
Plain wire	3.00
Barbed wire, galv. ..	3.85
Tinplate, 100-lb. box ..	$7.00

COKE.

Welsh foundry	72/6
„ furnace	57/6
Durham & North. foundry	70/-
„ furnace	54/6
Other Districts, foundry	77/9
„ furnace	45/-

SWEDISH IRON.

Bars, hammered basis sizes	Basis price. £ s. d.	
Rolled Ordinary—Assortment	31 0 0 to 38 0 0	
Nail Rods—Square, round and flats		
Keg Steel / Faggot Steel	about £50	Prices nominal.
Blooms—Single welded	£20 to £25	
Billets—Single and double welded	£22 to £27	
Pig-Iron—Grey, white or mottled	£15 to £20	

Prices are without engagement. All quotations are f.o.b. Gothenburg, net cash against documents there.

TUBES.

	Up to and incl. 2 in.	Over 2 in.
Gas	−10%	−15%
Water	net	+ 6¼%
Steam	+11¼%	+ 3¾%

REFRACTORIES.

	£ s. d.
Magnesite bricks, 2½ in., d/d	130 0 0
Do. 3 in., d/d	156 0 0
Common firebricks, 2½ in., d/d	10 0 0
Do. 3 in., d/d	12 0 0
Scotch firebricks, 2½ in., f.o.r.	12 15 0
Do. 3 in., f.o.r.	15 7 6
Sheffield quality, 2½ in., f.o.r.	11 0 0
Do. 3 in., f.o.r.	13 5 0
Silica bricks (ord.), 2½ in., f.o.r.	14 18 6
Do. 3 in., f.o.r.	17 18 6

All per 1,000 bricks.

Basic Dolomite	3 18 0
Dead burnt magnesite (peas and powder), d/d	22 10 0
Ground fireclay	1 10 0 to 2 0 0
Ganister	1 10 0 to 1 12 6

TINPLATES.

I.C. Cokes, 20×14, box	26/-
,, 28×20, ,,	52/-
,, 20×10, ,,	37/-
,, 18¾×14, ,,	29/-
Terneplates, 28×20, ,,	55/-

DAILY FLUCTUATIONS.

Standard Copper (cash).

	£ s. d.	
Mar. 16	67 0 0	No change
,, 17	67 0 0	No change
,, 18	68 0 0	inc. 20/-
,, 21	67 15 0	dec. 5/-
,, 22	68 0 0	inc. 5/-

Standard Tin (cash).

Mar. 16	153 0 0	dec. 80/-
,, 17	156 0 0	inc. 60/-
,, 18	154 15 0	,, 25/-
,, 21	156 0 0	,, 25/-
,, 22	157 0 0	,, 20/-

Zinc Sheets (spot).

Mar. 16	36 0 0	No change
,, 17	36 0 0	No change
,, 18	36 0 0	No change
,, 21	36 0 0	No change
,, 22	36 0 0	No change

Spelter (ordinary).

Mar. 16	26 0 0	dec. 15/-
,, 17	24 15 0	dec. 25/-
,, 18	25 0 0	inc. 5/-
,, 21	25 0 0	No change
,, 22	25 0 0	No change

Lead (English).

Mar. 16	20 10 0	No change
,, 17	20 0 0	dec. 10/-
,, 18	20 0 0	No change
,, 21	20 0 0	No change
,, 22	20 0 0	No change

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ROYAL EXCHANGE, MIDDLESBROUGH.

93, HOPE STREET, GLASGOW.

SITUATIONS VACANT AND WANTED.

HEAD FOREMAN wanted for large Bronze and Brass Foundry. Applicants must be first-class men on reverbatory furnaces, melting high-class bronzes and gunmetals for propellers and ships castings to Admiralty requirements; knowledge of machine moulding essential.—State age, experience, and wages to Box 698, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

MACHINERY.

FOR SALE.

No. 2 size Powerful PORTABLE FACING MACHINE, by J. Hetherington & Company, for roller paths of cranes, turntables.

VERTICAL BORING AND TURNING MILL, 57-in. table, two tool boxes on cross slide, by the Bullard Machine Tool Company.

VERTICAL BORING AND TURNING MILL, 50-in. table, two tool boxes on cross slide, by the Bridgeport Machine Works Company.

Two TWIN-SPINDLE VERTICAL BORING, DRILLING AND TAPPING MACHINES, 2¾-in. balanced spindles, by D. & J. Tullis.

One 32-in. SWING and one 28-in. SWING GISHOLT COMBINATION CAPSTAN LATHES.

Three nearly new 24-in. Centres All-Geared S.S.S. LATHES on 36-ft. bed, by G. & A. Harvey.

Twelve nearly new 18-in. Centres All-Geared Head S.S.S. LATHES, on 34 ft. 3-in. bed, by G. & A. Harvey.

Five 10-in. Centres Variable Speed, Single Pulley, Drive Boring, Facing and Parting-off LATHES, by J. Lang & Sons.

Powerful PLANING MACHINE, to plane 14 ft. x 5 ft. x 4 ft., two tool boxes, by J. Buckton & Company.

8ft. x 3 ft. x 3 ft. RACK DRIVEN PLANING MACHINE, two tool boxes on cross slide, by J. Butler & Company.

Several Motor Driven, Shunt Wound, Worm-Geared BOLLARDS, by L. Scott & Armstrong Whitworth. 2.75 to 6 h.p. to 20 x 6½, complete with starter.

50 FAN ENGINES, with 5-in. cyl., 4-in. stroke.

Steam driven ASH HOISTS, by Alley & McLellan, 4¾-in. cyl., 5½-in. stroke.

CATALOGUE OF STOCK MACHINERY, 5-6,000 LOTS, FREE ON APPLICATION. INSPECTION INVITED.

THOS. W. WARD, Ltd.,
ALBION WORKS, SHEFFIELD.
Telegrams: "Forward, Sheffield."
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MILD STEEL ROUNDS.

500 tons—1 11/16 in. diameter.
200 ton—1 7/16 in. diameter.
Lengths 5/8 ft.

Immediate clearance of above special items is required, as space occupied is wanted, and for orders of not less than 10 tons we are prepared to sell at extremely low figure of

£14 10s. per ton f.o.r. London.

The material is good quality, and is originally Bright Drawn Mild Steel, but owing to having been stored in open has become rusty.

Mention Reference KW/19.

THOS. W. WARD, LIMITED,
Silvertown, London, E.

40,000 HIGH GRADE STEEL BLANKS: 3 in dia. × ⅞ in. thick × ¾ in. hole; 3⅛ in dia. × ⅞ in. thick × ¾ in. hole; 4½ in. dia. × ⅞ in. thick × ¾ in. hole. Price 20s. per cwt. Samples free.—B.E. Co., 304, High Holborn, London, W.C

120 MILD STEEL BARS, 8 to 12 ft. long, 8¼ in. by 11/16 in.; 73 Bars good quality Iron, 1⅞ in dia.—F Wheeler, Midsomer Norton, Somerset.

FOR SALE, approximately 6,000 each of the following Fire Bricks: 9 in. by 6 in. to 5½ in. by 4 in., 9 in. by 5½ in. to 5 in. by 4 in., 9 in. by 4½ in. to 3¾ in. by 3 in., 9 in. by 5½ in. to 4½ in. by 3 in.; tapered for circle or arch. Made of best Stourbridge clay, guaranteed quality, being remains of contract for blast furnace material. Sample sent if required.—Write, stating best offer, to Box 718, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2

MISCELLANEOUS—*Contd.*

NON-FERROUS Foundry Business for Disposal. Four pit furnaces and excellent equipment, good shops and ample room for expansion. 30 minutes from Marble Arch. Low rents. Purchase money would include the benefit of current contracts.—Box 712, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

PHOTO-MICROGRAPHIC OUTFIT FOR SALE. Microscope, 5 Objectives, 4 Oculars, Micrometers, Prism and Beck-pattern Vertical Illuminators, Collective Lens, Triple Nosepiece, all by Zeiss. Also Stead-pattern Vertical Illuminator by Swift. ½-plate Camera, D.D. Slide with ¼-plate Adapters. Microscope and camera mounted to slide on 3 ft. 6 in. Baseboard. Complete working outfit capable of producing first-class photographs for metallographic purposes. Price, £60, or offer.—Box, 710, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

WANTED to Purchase, Surplus Stocks of Valve Stampings in the following steel specifications: K.8, K.9, S.19, and 3 per cent. nickel.—State size, price and quantity to Box. 714, Offices of the Foundry Trade Journal, Bessemer House, 5, Duke Street, Adelphi, London, W.C.2.

CHAPLETS, Pipe Nails, and Moulder's Brads. Names and addresses of actual manufacturers wanted by buyers.—Write Box 716, Offices of the Foundry Trade Journal, Bessemer House, 5 Duke Street, Adelphi, London, W.C.2.

FOR SALE, cheap, Foundry Pig Iron, all sections, F.B. Steel Rails, with all accessories; Joists, Channels, Angles, Sheets and Plates, all thicknesses; plumbago.—Ascog, Golder's Green, London. Telephone; Hampstead, 1806.

ENQUIRIES SOLICITED FOR CASTINGS IN IRON, machined or unmachined, up to 5 cwt. Complete Machines built throughout to specification. singly or in quantity. Jig and Tool Work a speciality.—C. S. Peatfield, Limited, Market Rasen, Lincs.

ADVICE and Handbook Free. — King's Patent Agency, Limited, Director, B. T. King, Reg. Patent Agent, 146a, Queen Victoria Street, E.C.4.

PATTERNS and CASTINGS SUPPLIED WHICH GIVE SATISFACTION. Inquiries solicited. Quotations by return of post or telephone. You can secure good-class work, reasonable prices, and promptitude in delivery by placing your orders with Videx Pattern Works and Foundry, Huntsworth Mews, Upper Baker Street, London, N.W.1. (Telephone, Paddington 364).

FOR SALE.—"Locomotive" Gauge, 2 ft. 10 in., wheel base 3 ft. 6 in., bore 6 in., stroke 10 in., saddle back, copper firebox, brass tubes. Also wagons and rails.—Ashton & Holmes Ltd., Macclesfield.

WANTED all users of METALLIC CEMENT to buy our PEERLESS brand, which produces "Artificial Iron" 10 lb. tin 10s., free delivered.—William Olsen, Ltd., Cogan Street, Hull.

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